# PSYCHE

## A JOURNAL OF ENTOMOLOGY

ESTABLISHED IN 1874

VOL. XXXV JUNE, 1928. No. 2

TABLE OF CONTENTS.

The Bee that Works in Stone: *Perdita opuntiæ* Cockerell. *C. P. Custer*.. 67
The Larva of Leptanilla (Hym.: Formicidæ). *G. C. Wheeler*..... 85
A New Species of Water Mite from Thermal Springs. *Ruth Marshall*.... 92
The Male Genital Tube of the Amphizoidæ. *R. J. Wilson*..... 98
The Nesting Habits of the Pulp-making Bee, *Alcidamea producta* Cress. *Phil Rau*..... 100
Two New Clavicorns from the United States. *D. H. Blake*..... 108
The Working Hours of Ants. *E. Seeman*..... 114
Some Cuban Cicadidæ, Cercopidæ, and Membracidæ. *J. G. Myers*..... 119
Biological Observations on *Nemeritis canescens* (Grav.) (Ichneumonidæ). *P. W. Whiting*..... 125
The Jurassic Insects of Turkestan. *T. D. A. Cockerell*..... 126
Notes on the Life History of *Pelecium sulcatum* Guérin. *George Salt*..... 131
Some Colombian Phoridæ from the Nests of Stingless Bees. *C. T. Brues*.. 134

# CAMBRIDGE ENTOMOLOGICAL CLUB


OFFICERS FOR 1928

*President* . . . . . JOS. BEQUAERT
*Vice-President* . . . . . F. M. CARPENTER
*Secretary* . . . . . J. W. WILSON
*Treasurer* . . . . . F. H. WALKER
*Executive Committee* . . . . . W. S. CREIGHTON, A. P. MORSE, O. E. PLATH

EDITORIAL BOARD OF PSYCHE

EDITOR-IN-CHIEF

C. T. BRUES, HARVARD UNIVERSITY

ASSOCIATE EDITOR

F. M CARPENTER

CONSULTING EDITORS

C. W. JOHNSON, Boston Society of Natural History.
NATHAN BANKS, Harvard University.
A. L. MELANDER, College of the City of New York,
A. P. MORSE, Peabody Museum, Salem, Mass.
J. H. EMERTON, Boston, Mass.
J. G. NEEDHAM, Cornell University.
W. M. WHEELER, Harvard University.


---


PSYCHE is published quarterly. the issues appearing in March, June, September, and December. Subscription price, per year, payable in advance: $2.00 to Snbscribers in the United States, foreign postage, 25 cents extra, Canada 15 cents. Single copies, 65 cents.

Cheques and remittances should be addressed to Treasurer, Cambridge Entomological Club, Bussey Institution, Forest Hills, Boston 30, Mass.

Orders for back volumes, missing numbers, notices of change of address, etc., should be sent to F. M. Carpenter, Bussey Institution, Forest Hills, Boston, 30, Mass.


IMPORTANT NOTICE TO CONTRIBUTORS.

Manuscripts intended for publication, books intended for review, and other editorial matter, should be addressed to Professor C. T. Brues, Bussey Institution, Forest Hills, Boston, 30 Mass.

Authors contributing articles over 8 printed pages in length will be required to bear a part of the extra expense, for additional pages. This expense will be that of typesetting only, which is about $2.00 per page. The actual cost of preparing cuts for all illustrations must be borne by contributors; the expense for full page plates from line drawings is approximately $5.00 each, and for full page half-tones, $7.50 each: smaller sizes in proportion.

AUTHOR'S SEPARATES.

Reprints of articles may be secured by authors, if they are ordered before, or at the time proofs are received for corrections. The cost of these will be furnished by the Editor on application.


Entered as second-class mail matter at the Post Office at Boston, Mass. Acceptance for mailing at special rate of postage provided in Section 1103, Act of October 3, 1917, authorized on June 29, 1918.

# PSYCHE

VOL. XXXV. JUNE 1928 No. 2

## THE BEE THAT WORKS IN STONE; *PERDITA OPUNTIÆ* COCKERELL[1]

By Clarence P. Custer,

University of Colorado, Boulder.

Some seven miles east of Boulder, nestled at the foot of the Colorado Rockies, there rise some sandstone cliffs of peculiar interest to the biologist and the geologist. These are termed the White Rocks in reference to their appearance when seen at a distance. Around them there stretch for miles and miles the fertile farming lands of Boulder County. Thus the White Rocks are isolated from other similar rock formations; and here there lives a bee that has been officially reported from nowhere else in the world. It is *Perdita opuntiæ* Ckll.[2]

One may find this remarkable bee in the early summer, in the months of May and June, as it hovers and darts from flower to flower in its tireless search for pollen. And in this one notices a peculiar adaptation. Apparently it visits but one plant species, the bright yellow flowers of the cactus, *Opuntia mesacantha* Raf.,[3] from which it derives its name. How specially adapted this insect is! Not content with limitation to White Rocks, it must also depend on the flowers of but one kind of plant for its existence.

[1]The writer is indebted to Mr. S. A. Rohwer and Miss Grace Sandhouse. for the determination of specimens; to Dr. Edna Johnson for the identification of some plants; to Miss Helen Mowry and Miss Celia Light for assistance in the photography and for helpful suggestions; to Professor R. D. George for some geological material as well as interesting information concerning tunnelways in the rock formations of different localities; and to Mrs. B. O. Custer, Miss Arline Elftman and Mr. Russel Mann for assistance in the field work.

[2]Determined by Miss Grace Sandhouse.

[3]Determined by Dr. Edna Johnson. Synonyms are *O. humifusus* Raf. and *O. rafinesquii* Engelm.

Undoubtedly the question now arises as to the reason for its limitation to White Rocks. Surely this is not due to its dependence upon the cactus flowers for the same species of plant has been found quite generally distributed thruout the West. There is but one solution left. It must be dependent upon the rocks themselves. And, to be sure, I was able to show that the nest of this bee actually was in the sandstone of this locality. This seems to indicate that the bee can not make its nest in earth but only in sandstone; and being so well isolated from all other available rock formation, it of necessity is limited to White Rocks. Two facts further strengthen this explanation: First, the bee is small and a weak flier—I have not found it beyond a radius of fifty yards from the nest. Second, due to the continual tillage of the soil, the cactus plants have practically been eliminated from the adjacent territory although they are very abundant at White Rocks. Thus the bee is apparently limited to this environment.

This remarkable locality has a peculiar history. According to Professor R. D. George, head of the geology department of the University of Colorado, the White Rocks constitute the so-called "Laramie formation." This was laid down in fresh water lake basins in which, at times, vegetation grew so abundantly that extensive deposits were formed. Later, these were changed by biochemical and dynamochemical processes to coal. The sandstone over the coal was formed by the carrying of sand into the lake basin and its later solidification by pressure and an added binding material. Following this, the lake disappeared. The rock, exposed to the atmosphere, dried, shrank and the stresses were relieved by cracks radiating from centers of stress. The connections between these joints formed polygonal blocks, or "turtle backs." The joints were deepened by water freezing and thawing thereby loosening the sand grains which were later carried away by the winds. This process was repeated and in time little basins, several feet in width, were formed until now, in some cases, the joints are less emphasized. The cliffs, which rise to a height of 87 feet, were the banks of the stream which had cut out the rock along its broad valley.

Furthermore, he made the interesting statement in August, after I had informed him that the bees were making their nests in the stone at White Rocks, that in 1903 he had seen some hymenopterous insects in some cactus flowers near Trinidad,[4] Colorado. At the time, while working on rock formations nearby, he found some small white bodies in the stone. These he thought were the pupal cases of ants. Then it was eight years later, in 1911, that he saw the bee, *Perdita opuntiæ*, in the cactus flowers at White Rocks. At that time he saw evidence of tunnels in the stone but did not associate them with the bee. And finally, in 1924, while studying the case-hardening of the stone at Rocky Flats Lake,[5] he saw similar tunnels in the rock. And so he now suggested that the bee might also be found at Trinidad and Rocky Flats Lake.

With this evidence in mind, I visited these two localities in search of the tunnels mentioned to see if by chance they could be those of *Perdita opuntiæ*.

Near Trinidad, 225 miles south of Boulder, the Laramie formation, of about the same hardness as that at White Rocks, was found. Cactus plants, not blooming at the time, (August) were present in some numbers but there was no evidence at all of tunnels in the stone. Only an area of ten square miles was covered. Possibly the nests might have been present nearby. But the only sure way of proving the absence of the bee from this locality would be to diligently search the cactus flowers in the month of June over an extensive area. And so, up to 1928, no bees of this species have been officially reported from the Laramie formation near Trinidad, Colorado.

In the second place, at Rocky Flats Lake, somewhat similar results were obtained. Only a very few cactus plants grew in the vicinity. However, here and there were some openings into the rock through which an iron wire could be pushed for a few inches. After chipping through the hard, granite-like surface of the stone to a depth of one or two inches, I came upon a sandstone approximately as soft as that at White Rocks. Through this I was surprised to find that in a few instances there

[4]Two hundred and twenty-five miles south of Boulder.
[5]Twenty miles south of Boulder.

were some tunnels about .6 cm. (¼ inch) wide, to a depth of about 10 cm. (4 inches). In them I did not find the larvæ of *Perdita opuntiæ* but a few brown cocoons of a wasp instead.

The bee which is apparently isolated at White Rocks is a small insect with black head and thorax and a clear amber-colored abdomen. It is scarcely 7 mm. (¼ inch) long. The face of the female is black; that of the male, partly yellow. One is struck by the fact that the pollen grains on the hind legs are distinctly larger than are the ocelli or simple eyes of this insect. See Fig. 3.

Correspondingly narrow are the galleries of this bee in the sandstone. The entrances to the nests are generally found on

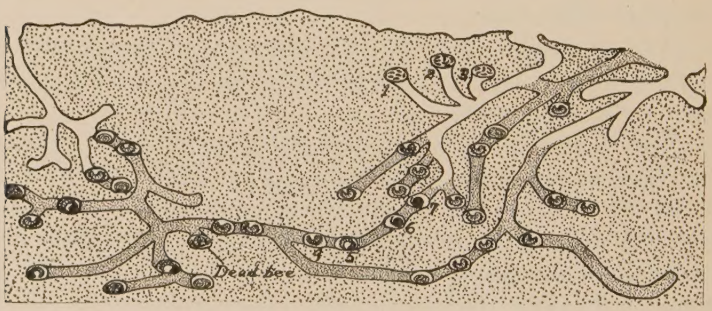



Fig 1.—The nest is composed of numerous tunnelways leading down from the surface of the stone. The larvae with their typical double-rowed sawtooth backs are shown in some of the cells. Heavy stippling indicates sandstone; light stippling, fine, loose sand. (Verticle section approximately one-third natural size.)

the upper surfaces of certain dome-shaped sandstone formations, some three to five yards wide[6]. Each nest has several entrances. These are more or less widened by the continual erosion of the stone. Hence, in a typical nest, one would expect to find three or four openings from 1-2 to 1 cm. in width, and separated from each other by a distance of about 10 cm. (4 inches). Most of these entrances are open. But, in a few cases, especially those leading almost straight down, the opening is closed with fine sand. However, the bees do not have difficulty in securing their entrance to these. They can not rake the sand out to open a passageway, for the fine particles would fall back on either

[6]See Plate II, middle figure.

side of their fore legs, much as would happen should we draw a needle through a cup of salt. So they merely insert their heads into the entrance, and made their way down thru the sand, which closes behind them. I have seen as many as four bees enter a nest thus in close succession, the one behind following quite close upon the disappearing abdomen of its leader. Once through the sandy entranceway, the bee attains the open tunnel, and thence proceeds without trouble. The pollen adheres to the bee's hind legs so tenaciously that but little is lost in the sand.

Since the nest has so many entrances, one would be right in assuming that there is more than one owner. Into one nest with three entrances, six bees were seen to enter. In another case I attempted to find the number of inhabitants. Armed with a stem of grass, I disturbed every bee that attempted to get out, thus causing its withdrawal into the tunnel. And, contrariwise, I permitted all bees, coming in from the fields, to enter without molestation. When I had waited thus for some fifteen minutes, and no more bees arrived, I stood back and counted the ones coming out. By this method I found thirteen bees, 11 females and 2 males.

When I was sure that all the bees had come out of the nest, I dropped some fine sand into the entrances. This filled them up, completely concealing them. Here, I took the following time notes, describing the return of the thirteen owners:

June 26. White Rocks.

10:47′. Seven bees arrive together from the fields. Unable to find the entrances, they francitally claw the sandstone, here and there, at about a centimeter from the closed openings.

10:50′. One bee finds entrance. It immediately makes way straight down thru sand. Two others see it enter, and rush to the spot, arriving a second after its abdomen has disappeared. These enter the sand in like manner.

10:50′: 45″. The last two bees come out head first, having failed to find the entrance. Pollen still on legs. They fly around a short distance from nest, alighting, at intervals, to dig wildly around entrance.

11:01′. More bees arrive from fields. Very much excited.

11:03′:30″. Another finds an entrance. Four others rush to the spot. These enter in succession, the one behind quite close upon the abdomen of its predecessor. Sand closes over the last bee.

11:06′. Still seven left out unable to find an entrance.

11:08′:15″. Another bee finds an entrance. Two more follow it closely. Sand closes over last.

11:10′. Remaining bees enter nest in like manner. Entrances to nests are as well concealed as ever.

11:14′:50″. A bee comes out, head first. Flies away.

11:15′:30″. Returns and enters nest as before. Backs up tunnel pushing mound of sand up over the entrance with its abdomen.

11:18′:15″. Pushes sand up again. Repeats several times.

11:21′:30″. Entrance now free of sand. Bee continues backing up tunnel. Several bees leave the nest by another entrance.

The bee does not come directly to the nest from the fields. It will first alight on a rock, a few meters away. Here it will remain quiet for a minute or two, and presently fly on to alight a meter or so nearer the nest. Perhaps it will pass over the nest two or three times in this manner. Finally, after having alighted several times, it will fly directly to the entrance, hover over it for a moment, and enter. This probably serves to deceive any parasites which may attempt to follow it to the nest.

This species undoubtedly builds its own nest. This is composed of numerous tunnelways leading down from the surface of the stone for a distance of about 7 to 10 cm. (3 to 4 inches). From these several more or less horizontal galleries branch off leading to the cells for the reception of the future generations. The tunnels from several entrances often join one another at varying distances beneath the surface. Hence a nest may have several entrances. In Fig. 1, four entrances are shown. Three of these were close together and the fourth was about 20 cm. (8 inches) away. The vertical depth was about 7.5 cm. (3 inches). Most of the passageways were in about the same plane suggest-

ing that the bees took advantage of a fault in the stone to excavate their nest. Such a crack, if present, was hardly noticeable from the surface.

In some cases, one does not find such distinct galleries branching off from the tunnels in the stone. Thus upon chiseling out the nest used by thirteen bees I came across a most peculiar structure. The tunnelways from the entrances led down in a typical manner to a depth of 2 or 3 cm. (one inch). Here they began to branch and merged abruptly into an area of dark, moist sand about the size of one's two fists. Lower Figure Plate II is a photograph of this nest. It was taken after the moist sand with its contents had been removed. The accompanying drawing, Fig. 4, shows the larvæ as they would have appeared had the fine sand been transparent.

The explanation of such a nest is probably as follows: Apparently the bees had been working on the nest for years and years. Each season a new brood continued the work of excavation. And each year the branching galleries became more and more complicated, until, finally, nothing was left of the sandstone walls between the tunnels. Just a mass of the dark, moist sand remained.

Embedded in this chamber of sand, 215 larvæ, each within its mud-like cell, were present. Here and there was a dead adult, a silent reminder of the past season's activity. If it is true that there were but eleven females in this nest of 215 larvæ, then each female laid at least 19 eggs.[7] This is in harmony with the findings of Fabre ('15). He states further that after the bee has laid her limit of eggs, she continues her work of provisioning cells which are finished and closed up just as if the egg had been laid:—

"I seem to see. . . . . a rough image of the industrious persistency of the insect, still toiling away at its business, even when there is nothing useful left to do. This worker knows no rest but death."

Perhaps the same explanation could be offered for the presence of over a dozen such cells in this nest. In each of these

[7]"The total number of eggs laid not only by the Osmiæ but by a host of other bees fluctuates round about fifteen."—Fabre.

there was found a typical ball of pollen, as had been present in all of the rest, but no signs of an egg or larva.

Some of the chambers for the young bees, i. e. numbers 1, 2 and 3 in Fig. 1, were but a centimeter from the surface. At the time of my chiseling these out, I saw on their walls patches of pollen of the same size as the loads on the hind legs of the females. Here, the bees were apparently forming a supply of pollen before shaping it into a ball for the young embryo. The walls of these chambers were smoothly lined with a mud-like material.

Between the cells containing the larvæ the tunnel was filled up with loose sand. This was somewhat damp and more darkly colored than the surrounding stone This probably prevents certain enemies from reaching the young bees, during the hot summer months of July, August and September when the builders of the nests are dead.

In cells labeled 4, 5, 6 and 7, Fig. 1, one sees the stages in the development of the young embryo. Thus, in cell 4 there was a large, well-grown larva, without any visible pollen.

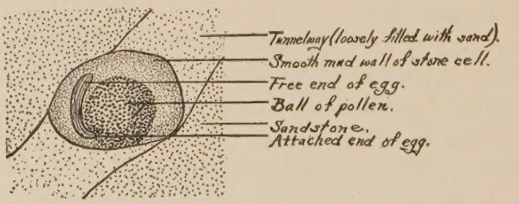



Fig 2.—The egg of the species is crescent-shaped. (Taken from Fig. 1, cell 7).

But in cell 5, the larva was not so well developed, having eaten but half of its provision of pollen and honey. The egg for this one had been laid later. Further along, in cell 6, a large ball of pollen, 2.5 mm. in diameter was present. On its side there was a slightly developed larva, just out of the egg. And finally, in cell 7, there was a similar ball of pollen with an egg along the side. One end was inserted into the pollen. Apparently it had just been laid. This latter chamber is shown in Fig. 2. The egg of this species is somewhat crescent-shaped, quite smooth,

glistening and opalescent. It is approximately 1.5 mm. in length, being about one-fifth as wide as long.

In looking through the literature, I find no report of any bee, or wasp, for that matter, digging its nest out of stone. In the study of the thousands of species of wild bees one finds many different methods of nesting. The most common of all bees, those of the genus *Megachile*, excavate tunnels, to a depth of several inches, in the earth or in other suitable places such as the dried stems of pithy plants. In these they construct several cells, each about a centimeter long, out of pieces of leaves which they cut from nearby plants. These cells are partially filled with pollen and honey and an egg is laid therein. This hatches and usually takes a year to mature. The process is then repeated. Each nest is usually built by but one bee; she lives but a month or two. The males never help in the nesting. Bees of another genus, *Xylocopa*, excavate similar tunnels in wood and use sawdust to make the cells. Others, of the genus *Anthidium*, find tunnels already constructed, usually in the earth. In these, they place cells made of a cottony material consisting of hairs scraped from plant stems. Then they fill up the tunnel above the cells with the cottony material, soil or pebbles, etc., according to the species. And others of the genus *Dianthidium* construct their cells out of a resin which they secure from certain plants, such as the sunflower, *Helianthus petiolaris*. Here it occurs in drops on the leaves and stems. Some of the species make their cells on rocks, others in the ground etc. Some are solitary; others are colonial. One of the latter species even keeps two nests going at the same time. See Custer and Hicks ('27). Still others, known as the burrowing bees, such as those of the genus *Melissodes* or *Anthophora*, dig out extensive galleries in the earth. These line their cells with a smooth mud-like material probably made by lapping the cell-walls with their tongues. Then there are the bees of the genus *Osmia* that dig tunnels in the earth, old logs etc. These construct their cells out of macerated plant leaves etc. And, finally, there are bees that make no nests at all. They are parasites on other bees. Among these we find the genera *Cœlioxys* (parasitic on *Mega-*

*chile*), *Triepeolus* (on *Melissodes* etc.), and others. They lay their egg alongside that of the host in the cell. Then, according to Fabre ('15), the parasite's egg hatches out and its first instinct is to seek out and destroy the egg of the host. It then develops, usually throughout the winter to come out the next summer as the adult. Thus each bee and each genus has its own peculiar methods of nesting. Many more interesting details can be obtained from Fabre's works. And many interesting facts remain yet to be found in nature.

The small bees of the genus *Perdita* are found chiefly in the arid south-western region of the North American Continent. Some have been found in Canada (*P. canadensis* Crawford and

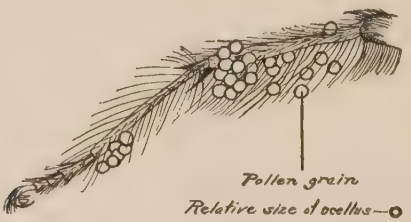



Fig 3.—The pollen grains on the hind legs of the female are larger than the ocelli. (Hind leg of female X33 diameters).

*P. citrinella* Grænicher); others in Mexico (*P. mexicanorum* Ckll).[8] Between these two countries the bees of this genus are abundant, especially in New Mexico. *P. albipennis*, a western form, is found from South Dakota and Nebraska through Colorado and New Mexico into Texas, according to Grænicher ('14).

Before Professor Cockerell ('96) started his work on this genus, only 17 species were known. By 1896 he had added 53 new species to the list. Of these, 26 were known in both sexes, 26 only in the male, 18 only in the female. The flower visiting habits of 50 species were known. Their nesting habits were as yet unknown. Fifteen years later, in 1911, he reported a list of

[8]Prosessor Timberlake informs me that the genus is recorded on the Atlantic coast from Guatemalo to New Brunswick; on the Pacific coast from Lower California to Victoria, British Columbia, at which latter place he has found an as yet undescribed species. He is at present describing some fifty new species, mostly from California.

149 members, over twice as many as were known in 1896. By 1922 the list had been further enlarged by at least ten more species. Up to this time, the nests of but two species had been observed: In 1910 Grænicher had reported that *P. maculipennis* made its nest in sandy soil in Wisconsin. And in 1920 J. Bequaert ('20) had stated that *P. octomaculata* was seen nesting in sandy soil at Forest Hills.

By 1896 only two species were found east of the Mississippi These were *P. octomaculata* Say, a northern type, and *P. obscurata* Cr., a southern species occurring in Georgia and Florida. However, by 1914, twelve eastern species were reported. Six of these were from Wisconsin.

According to Professor Cockerell and others, it may be laid down as a general rule that each species of *Perdita* visits, normally, but one species of flower. More than half of these flowers are *Compositæ*. These bees do not usually frequent the northern type of flowers but rather those that extend northward from the neotropical region. This, taken with the normal distribution of the genus, strongly suggests that in the main we have to do with a southern series of types which have spread northward and become largely differentiated since the glacial epoch. But we must look upon *P. octomaculata* as a survivor from pre-glacial times.

The great majority of the members of this genus fly in the late summer and autumn. Few have been seen both in spring and late summer but Viereck (Ckll '11) has collected *P. phaceliæ* in May and *P. pectidis* in April in New Mexico, these being previously known as September bees. And so in these cases there are apparently two broods each year or else the September brood hibernates through the winter. At White Rocks, but one brood of *P. opuntiæ* is found each year. Even by December I have been unable to find any cocoons spun by the larvæ. The cocoons shown in Fig. 1 are probably those of parasites.

*Perdita opuntiæ* is not the only bee that confines its visits to the cactus flowers. Professor Cockerell has shown that the genus *Lithurgus* and certain members of *Heriades* and *Ashmeadiella* are confined to their flowers for their pollen. Professor

Toumey has shown that certain species of cactus have almost lost the ability to produce seed but propagate by means of falling joints which take root, and yet their flowers are adapted to bees and are visited by a series of bees more or less peculiar to them. Thus *Ashmeadiella cactorum* Ckll. visits cactus at Santa Fé in July.

These bees are usually short of flight. Some claim that this is so because they are small. Others want proof for such statements and offer other explanations. Thus Robertson ('12) explains it by saying that the short flight is the result of the visiting of the few closely allied genera of plants. In order to visit a few genera they have to be where those few are abundant. And so each year they nest in the neighborhood of the flowers on which they depend. Being near to these flowers each season, they are therefore short flighted. Both opinions are probably right. Apparently but little actual field work has been done on this problem.

It is evident that there are other bees of this genus which are apparently limited by their environment as much as is *Perdita opuntiæ*. Thus M. H. Swenk and T. D. A. Cockerell ('07)

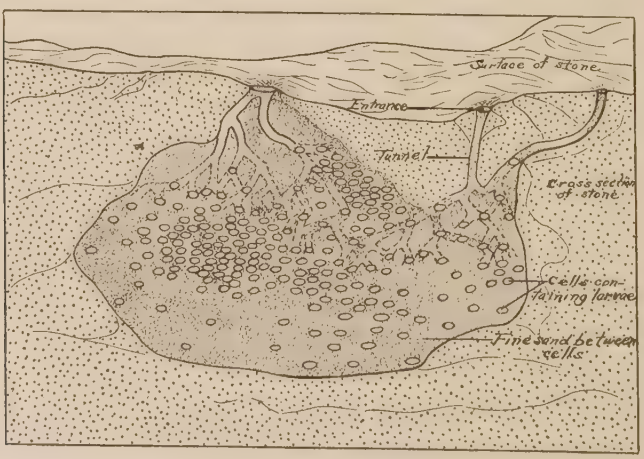



Fig 4.— A drawing explaining Plate II, lower figure. This is a vertical section through the sandstone. The cells are shown as though the sand between them were transparent. In reality they are in several different planes.

state that *P. crawfordi* Ckll. has never been taken away from the environs of the salt flats west of Lincoln, Nebraska. Perhaps in this as well as in other cases, similar geological limits are set on the bee, the same as on *P. opuntiæ*. Further investigation of this point would probably be interesting.

Various investigators have found evidences of adaptation to new conditions, of extraordinary splitting up into a great variety of forms and, in general, of considerable signs of evolution going on within this genus. Professor Cockerell thus states "we have indeed the process of evolution going on under our eyes, the puzzling forms being those which have only lately segregated themselves and have not yet developed striking peculiarities." Grænicher brings forth some evidence when he states that *P. maculipennis* obtains her pollen from the white melilot which was introduced from Europe. Here there occurred an adaptation to new conditions brought about by the fact that the native plant or plants visited originally by this bee did not occur in the type locality at the time the bee was found.

With these facts in mind, Professor Cockerell has advanced the following five possibilities of processes that may be going on in the formation of new species in the genus *Perdita*:

1. Mutations having no adaptive significance.
2. Results of the crossing of mutants.
3. The sorting out of certain characters as dominant (in the sense of prevalent) but not necessarily aided by natural selection or sexual selection.
4. The occasional coincidence of adaptive features (often physiological or such morphological ones as length of tongue) which favor a change of habits or environment and permit the insect to become attached to a different genus of plants.
5. The new type having been isolated on a new plant, or geographically or seasonally isolated will eventually settle down to a new position of stability (aided by natural selection) which will be sufficiently remote from that of the parent species to maintain it as a distinct entity in nature, and usually prevent crossing.

The complexity of the genitalia will cause slight modifications to result in physiological isolation.

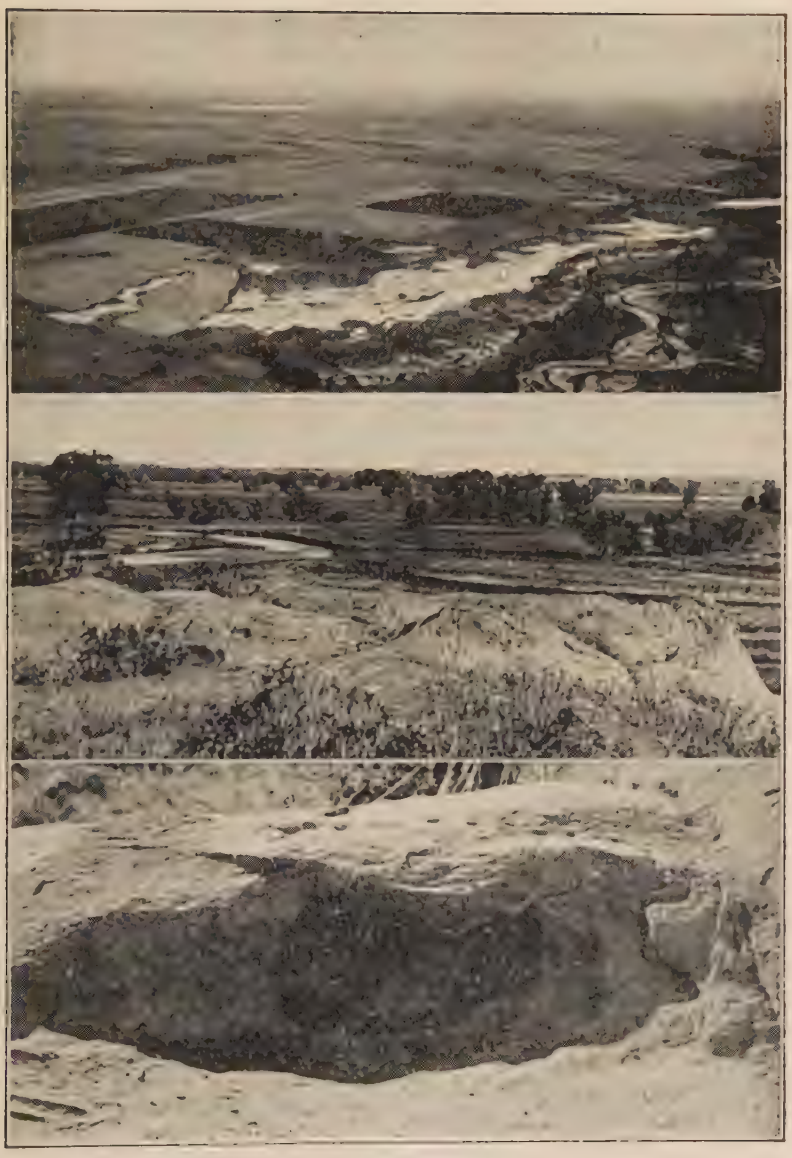
In the case of the bee, *Perdita opuntiæ*, progressive excavation of the nest is probably continued year after year, by this means leading to the complicated galleries in the stone. In Fig. 1, the nest at the extreme right had four blind pockets which were not constructed into chambers. In other places, similar extensions were present. These, along with the old chambers, undoubtedly would have been used by the next year's brood.

In places, as labelled in this same drawing, one could see a cocoon[9] or dead bee. So, by June 21, when the nest was chiseled out, the process of provisioning was near completion. By the first of July, the cactus flowers were beginning to disappear, and by the eighth not a bee of this species was to be seen at White Rocks. Just a very few of the cactus flowers remained. The bee had disappeared for the year. The larvæ were beginning their long period of development, waiting quietly through the long months of the hot summer and bleak winter in their cells of stone, inpreparation for the emergence next spring as adult bees.

Before this time, on June 20, I had covered the White Rocks from end to end mapping out the distribution of the bees as I found them in the cactus flowers. This covered a territory two and a half miles long by one quarter mile wide. Everywhere that I found the cactus flowers, numbers of these bees were present. This plant is a native of this country. Beyond a doubt, when the Indians used the White Rocks as a look-out station,[10] in the pre-pioneer days, the cactus plants were quite generally distributed all around the territory. Perhaps a long time before that there were numerous rock formations all over the West, in which the bee made its nests. As time passed on, these disappeared, leaving the White Rocks as an erosive remnant on which *Perdita opuntiæ* and its favorite cactus flowers were stranded. Perhaps extensive collecting would reveal this bee at some other sandstone formation where it had been similarly isolated. Up to this time, September, 1927, no such proof is

[9]Probably of a parasite.

[10]Numerous implements used by the Indians have been recovered from the White Rocks. These include, especially, mortars, pestles, etc.



CUSTER—PERDITA

available. The bee is still to be found only at White Rocks. Is it possible that it arose here in its evolution?

## SUMMARY.

1. *Perdita opuntiæ* is a wild bee which has been reported from nowhere else but White Rocks, Colorado.

2. It is isolated here because it must make its nest in sandstone.

3. The isolation of White Rocks by large areas of tilled land prevents the spread of this bee.

4. It visits the flowers of but one plant species, the cactus, *Opuntia mesacantha* Rafinesque.

5. There are several entrances and about ten inhabitants to each nest.

6. The bees usually alight several times on nearby rocks before entering their nests.

7. In some cases, the inhabitants have the peculiar habit of disappearing into the sand to gain entrance to their nests.

8. *Perdita opuntiæ* is to be found at White Rocks during the latter part of May, all of June and early July.

9. This is apparently the first bee reported to make its nest in stone.

## BIBLIOGRAPHY

1. *Bequært, J.*
'20 Hymenoptera Collected near Boston, Mass., with Description of a Variety of *Bombus affinis*. Psyche, 27: 6-12.

2. *Cockerell, T. D. A.*
'96 The Bees of the Genus *Perdita* F. Smith. Proc. Acad. Nat. Sci. Philadelphia, 48: 25-107. 15 figs.

3. *Cockerell, T. D. A.*
'00 The Cactus Bees; Genus *Lithurgus*. The Amer. Naturalist, 34: 487-488.

4. *Cockerell, T. D. A.*
'11 A List of the Bees of the Genus *Perdita* Smith. Psyche, 18: 134-143.

5. *Cockerell, T. D. A.*
'19 The Bees of Peaceful Valley. Jour. New York Entomological Society, 27: 298-300.
6. *Cockerell, T. D. A.*
'22 Bees of the Genus *Perdita* from the Western States. American Museum Novitates, 33:115.
7. *Custer C. P. and Hicks C. H.*
'27 Nesting Habits of Some Anthidiine Bees. Biol. Bull. 52: 258-277.
8. *Custer, C. P.*
'27 Nest Habits of a Solitary Bee of the Genus *Spinoliella* of Ashmead. Psyhe 34: No. 6, 200-202.
9. *Fabre, J. Henri.*
'15 Bramble Bees and Others. English Trans. New York.
10. *Grœnicher, S.*
'10 Wisconsin Bees; New and Little Known Species. The Canad. Ent., April: 101-104.
11. *Grœnicher, S.*
'14 Wisconsin Bees of the Genus *Perdita.* The Canad. Ent., 46: 51-57.
12. *Molyshev, S. I.*
'27 The Nesting Habits of *Dasypoda* Latr. (Hym., Apoidea); Travaux de la Société des Natulatistes de Leningrad (Petrograd); r., T. lvi B. 2.; pp. 123-146.
13. *Robertson, Charles.*
'12 Origin of Oligotropy of Bees (Hym.). Ent. News, 25: 67-73.
14. *Swenk M. H. and Cockerell, T. D. A.*
'07 The Bees of Nebraska, Family *Panurginæ.* Genus *Perdita* Smith. Ent. News, Feb.: 51-58.

Explanation of Plate II.

Above

The home of the Worker in Stone. This is a view from an aeroplane looking north-east. It shows the complete isolation of White Rocks. In the right corner runs the stream in double "S" formation. The white streak at the extreme right is the tail of the aeroplane.

Middle

The entrances to the nests are generally found on the upper surfaces of certain dome-shaped sandstone formations. In the background runs the stream which has carved the cliffs of White Rocks. Ten or twelve nests are present in this picture.

Below

A peculiar nest that was over-tunneled by the bees. This photograph was taken, after the sand containing the cells had been scraped away, in order to give depth to the drawing in Fig. 4. (Approximately one-fourth natural size.)

# THE LARVA OF LEPTANILLA (HYM.: FORMICIDÆ)[1]

By George C. Wheeler,

University of North Dakota

## **Leptanilla revelierei sardoa** Emery

*Larva*:Body long, slender ,subcylindrical, or thocephalic and straight except for the thorax which is slightly curved ventrally; with eleven distinct postcephalic segments. Diameter greatest at the sixth abdominal segment; decreasing slightly toward the posterior end which is rounded and terminates in a small hemisspherical boss; and diminishing progressively to the anterior end, except for a slight constriction at the first abdominal segment. Relative diameters of the segments (beginning with the prothorax as the unit): 1.00-1.30-1.50-1.45-1.80-2.00-2.45-2.80-3.00-2.95-2.75. Relative lengths of segments: 1.0-1.9-3.4-3.1-3.6-4.0-5.3-4.0-3.7-3.3-7.7. (Fig. 1*A*)

Projecting downward and forward from the ventral side of the prothorax there is a curious structure suggestive of a plowshare. This is furnished with three hairs: a short, simple, slightly curved seta arising just back of the apex on the ventral side, and two longer pendulous hairs, which are curved at their distal ends and bifid at the tips, arising dorsolaterally just back of the middle of the structure. (Fig. 1*B* and *E*)

On either side of the fourth abdominal segment near the posterior border there is a bare circular area enclosed by a narrow heavily chitinized band, the whole structure (provisionally called "tympanum") being about 0.037 mm. in diameter. It is bordered by a fringe of stiff hairs, which are stouter and a trifle longer than those on the adjacent integument; there are also a few of these on the heavily chitinized band. Attached to the bare area near its posterior margin is an internal tube-like structure; this is twice bent and its diameter increases toward the inner end; its length is about 0.06 mm. (Fig. 1*D*)

[1]Contribution from the Zoölogical Laboratory of the College of Liberal Arts at Syracuse University.

Hairs of four types: (a) Minute, thin, somewhat flexuous hairs (length 0.01-0.03 mm.), which form a rather dense covering for the entire body, except the head, prothorax, "tympanum," and caudal boss; these are arranged in transverse rows encircling the body; they are spaced at distances roughly equal to their length, which is least at the anterior end and greatest at the posterior. (b) A few short, stout, rather stiff hairs, irregularly distributed and ranging in length from 0.02 mm. on the prothorax to 0.08 mm. on the last abdominal seg-

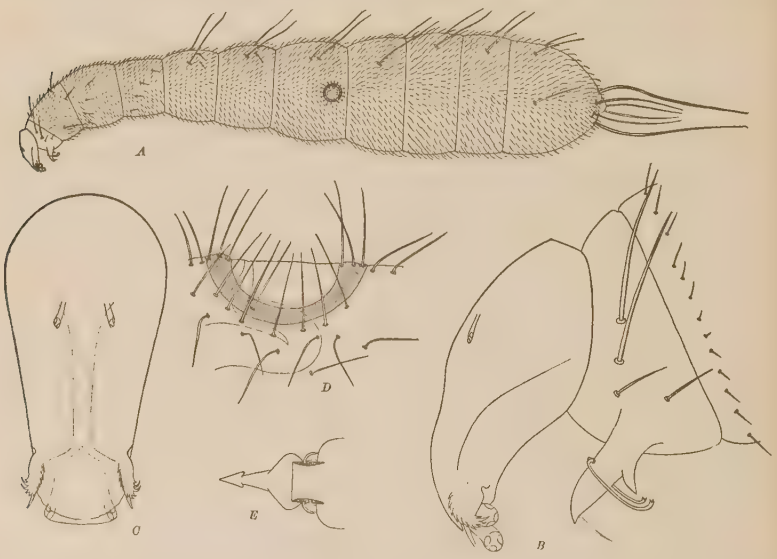



Fig. 1.—Larva of *Leptanilla revelierei sardoa* Emery: *A*, in profile, X60; *B*, head and prothorax in profile, X410; *C*, cephalic aspect of head, X400; *D*, "tympanum," dorsal view, X580; *E*, cephalic aspect of plowshare-like organ on prothorax, X425.

ment. (c) Long hairs with rather flexuous tips arranged symmetrically in pairs on the dorsal surface, one pair each on the second to seventh (inclusive) abdominal segments; varying in length from 0.13 mm. to 0.16 mm.; four of the longest forming a ring around the base of the caudal boss. Just outside this ring there are attached (d) two extremely long (0.3 mm.) hairs; these six hairs converge apically and give the appearance of a caudal appendage.

Head (Fig. 1*C*) minute, naked, its outline pyriform when viewed from in front, twice as long as its greatest breadth (which is one-fourth of its length from the occipital border), narrowed at the base of the mouth-parts, with the occipital border broadly rounded. Antennal rudiments situated one-third of the length of the head from occipital border; long, narrow and apparently adnate to the head. Tentorium (?) conspicuous, in the form of a long, narrow, median bar, which is abruptly widened at the posterior end and furcate anteriorly, each division leading toward the base of a mandible.

Labrum semicircular, the margin finely undate, the basal angles produced outside the mandibles into stubby flaps which are toothed on their anterior and distal borders (Fig. 1*B*). Mandibles long, slender, slightly curved, acute, simple, feebly chitinized and directed downward and somewhat backwards along the sides of the labium. Maxillæ lobiform, each with three sensillæ. Labium narrowed at the base, broader at the distal border, which is smooth and slightly curved; with lobiform sense-organs at the anterior corners, each with three sensillæ; opening of sericteries not evident. Trophorhinium wanting.

This description is based on three larvæ, which have been cleared in potassium hydroxide (10%), stained with acid fuchsin, and mounted in balsam on slides. They are labeled "Sardegna: Golfo Aranci. I. 1909 A. Dodero."

I am indebted to Dr. Rafaelo Gestro of the Museo Civico di Storia Naturale of Genoa, thru the kindness of Dr. W. M. Wheeler, for this material.

The genus *Leptanilla* has always been more or less *incertæ sedis*. Emery, when he established it in 1870, placed it in the "Dorylidæ" near *Typhlopone*. Mayr, however, in a letter to Emery (date not given—see Emery 1904) dissented, maintaining that it belonged with the Myrmicinæ. Emery was evidently convinced, for in 1875 he removed it to the "Mirmicidei" in the neighborhood *Stenamma* and *Liomyrmex*. In 1877 he moved it to the vicinity of *Monomorium* and *Leptothorax* in the "Myrmicidei genuini" but marked it with a query to signify uncertain position. In 1881 Ern. André had it in the first tribe, "Myrmi-

cidæ veræ," of the "Myrmicidæ" but mentioned its affinities with the "Dorylides."

Forel in 1893 did not mention the genus but might have meant to include it in the subfamily Myrmicinæ, when he said that the fourth tribe ("Myrmicii") included "les autres genres de la sous-famille des Myrmicinæ." And later (1901) he excludes it from the Dorylinæ when he says, "Donc, je maintiens la sous-famille *Dorylinæ* limitée aux genres *Dorylus, Aenictus, Eciton* et *Cheliomyrmex*." In von Dalla Torre's "Catalogus" (1893) it was still in the Myrmicinæ but near *Trigonogaster* and *Pheidologeton*. In 1895 Emery was still of the opinion that it belonged in the subfamily "Myrmicini" in the second tribe ("Myrmicii") near *Huberia* and *Phacota*. But nine years later (1904), after describing the female of *L. revelierei* Emery, he returned it to its original subfamily (Dorylinæ). In the following year, however, in Ashmead's skeleton it stood between "?*Liomyrmex*" and *Epipheidole* in the tribe Stenammini, subfamily "Myrmicinæ," family "Myrmicidæ". In 1907 Santschi described males of three species, which he referred to the Genus *Leptanilla* and claimed that their doryline affinities justified Emery's original allocation of the genus. It should be noted, however, that males of *Leptanilla* have never been taken with females or workers; hence it is not certain that those described by Santschi belong to this genus. In the "Genera Insectorum" (1910) Emery established for the genus a separate tribe (Leptanillini) in the subfamily Dorylinæ, where it seemed destined to abide in isolation; Wheeler (1910: "Tribe Leptanillii"), Forel (1917), and Forel (1921: tribe not given), and Wheeler (1922) have not disturbed it. But recently Wheeler (1923) has suggested that even further isolation may be necessary:

"Most myrmecologists recognize only five subfamilies of ants and regard the Cerapachyinæ as belonging to the Ponerinæ, the Pseudomyrminæ to the Myrmicinæ. It is probable, however, that future myrmecologists will increase the number of subfamilies. I believe that the tribe Leptanillini, which Emery includes among the Dorylinæ, will have to be separated out as a distinct subfamily (Leptanillinæ). Dr. George C. Wheeler

finds that the larva of Leptanilla is very aberrant, and the characters of the adult are either quite unlike those of other Dorylinæ or only superficially similar and due to convergence, or similarity of subterranean habits." (page 335)

The larva of *Leptanilla* does bear certain resemblances to the known doryline larvæ (*Dorylus, Aenictus, Eciton, Cheliomyrmex*): the long, slender, subcylindrical, orthocephalic, nearly straight body, narrowed progressively from behind forward; the small, feebly chitinized mandibles; the absence of a trophorhinium on the mouth-parts. On the other hand, it differs in the constriction at the first abdominal segment; the long hairs on the abdomen, especially the extremely long pair at the posterior end; the absence of hairs on the head; the shape of the head, which in the Dorylinæ is suborbicular. But these differences become trivial and insignificant beside the four which not only differentiate it from the Dorylinæ, but also from all other known formicid larvæ (130 genera). *Leptanilla* is unique in the (1) possession of the plowshare-like structure on the ventral side of the prothorax, (2) the "tympanum" on either side of the fourth abdominal segment and (3) the toothed flaps of the labrum and (4) in the position of the mandibles, which are directed downward and somewhat backward along the sides of the labium instead of lying across the front of the labium with their apices nearly touching or crossed.

These aberrant characters of the larva of *Leptanilla* support the contention of Dr. W. M. Wheeler (quoted above) that the tribe Leptanillini should be removed from the Dorylinæ and raised to the rank of a subfamily.

Concerning the functions of these peculiar structures nothing is known. The plowshare-like structure on the prothorax might be an exudatorium; the "tympanum" suggests an auditory organ. If the larvæ of this rare ant (or of any related species) are ever collected again, they should be kept alive in an artificial formicary and studied for the purpose of solving these problems. Also some specimens should be suitably killed and fixed for histological examination.

It is interesting in this connection to note that another

formicid subfamily has been based partly upon larval characters, namely, the Pseudomyrminæ established by Emery in 1899. It is now known that the characters he used (hypocephaly and the presence of antennal rudiments) are not distinctive. Valid characters were found, however, by Wheeler and Bailey (1920) in their study of the larvæ of *Pseudomyrma*, *Tetraponera*, *Pachysima*, and *Viticicola*: the straight cylindrical body and the trophothylax. And Wheeler (1920, 1922, 1923) has since recognized the group as a distinct subfamily.

*Literature Cited.*

André, Ern.

1881-1882. Species des hyménoptères composant le groupe des formicides d'Europe, etc. Gray, pls. 1-25, 8 suppl.

Ashmead, W. H.

1905. A skeleton of a new arrangement of the families, subfamilies, tribes and genera of the ants, or the superfamily Formicoidea. Canad. Ent. 37: 381-384.

von Dalla Torre, K. W.

1893. Catalogus Hymenopterorum hucusque descriptorum systematicus et synonymicus. Vol. VII: Formicidæ (Heterogyna). viii, 289, Leipzig.

Emery, C.

1870. Studi myrmecologici. Boll. Soc. Ent. Ital. 2: 9 p.,1 pl.

1875. Le formiche ipogee, con descrizione de specie nuove e poco note. Ann. Mus. Civ. Genoa 7: 465-474, 1 fig.

1877. Saggio di un ordinamento naturale dei myrmicidei e considerazioni sulla filogenesi delle formiche. Boll. Soc. Ent. Ital. 9: 1-17, 1 pl.

1895. Die Gattung Dorylus Fabr. und die systematische Eintheilung der Formiciden. Zool. Jahrb. Abt. Syst. 8: 685-778, 3 pl., 41 fig.

1899. Intorno alle larvae di alcune formiche. Mem. Accad Sc. Bologna (5), 8: 3- 10, 2 pl.

1904. Le affinità del genere Leptanilla e i limiti delle Dorylinæ. Arch. Zool. Napoli 2: 107-116, 9 fig.

1910. Family Formicidæ, Subfamily Dorylinæ in Wytsman's "Genera Insectorum." Fascicle 102, 34 p , 8 fig., 1 pl.

Forel, A.

1893. Sur la classification de la famille des formicides, avec remarques synonymiques. Ann. Soc. Ent. Belg. 37: 161-167.

1901. A propos de la classification des formicides. Ann. Soc. Ent. Belgique. 45: 136-141.

1917. Cadre synoptique actuel de la faune universelle des fourmis. Bull. Soc. Vaud. Sc. Nat. 51: 229-253

1921. Le monde social des fourmis du globe. Vol. I. xiv, 192, 3 pl., 30 fig. Geneva, Librairie Kundig.

Mayr, G.

1877. Ueber Dr. Emery's Gruppierung des Myrmiciden. Sitzb. Zool.-bot. Gesell. Wien 27: 23-26.

Santschi, F.

1907. Fourmis de Tunisie capturées en 1906. Rev. Suisse Zool. 15, 2: 305-334.

Wheeler, W. M.

1910. Ants: Their structure, development and behavior. xxv, 663, 286 fig. New York, Columbia University Press.

1920. The Subfamilies of Formicidæ, and other taxonomic notes. Psyche 27: 46-55, 3 fig.

1922. Ants of the American Museum Congo Expedition. A contribution to the myrmecology of Africa. Bull. Amer. Mus. Nat. Hist. 45: 1-1139, 103 fig., 47 maps, 45 pl.

1923. Social life among the insects. Being a series of lectures delivered at the Lowell Institute in Boston in March 1922. vii, 375, 116 fig. New York, Harcourt, Brace and Company, Inc.

Wheeler W. M. and Bailey, I. W.

1920. The feeding habits of the Pseudomyrminæ and other ants. Trans. American Phil. Soc., Art. 4, 237-278, 6 fig., 5 pl.

# A NEW SPECIES OF WATER MITE FROM THERMAL SPRINGS

By Ruth Marshall,

Rockford College, Rockford, Illinois.

During the summer of 1927, Professor Charles T. Brues, of the Bussey Institution for Research in Applied Biology, found several water mites in collections made in thermal springs of Nevada in the course of his investigations upon the life in such habitats. He kindly sent these specimens to the writer for further investigation.

A search in the literature of the Hydracarina reveals very few records of their occurrence in thermal waters. Dr. Karl Viets, of Bremen, who has studied the group extensively, confirms this statement in a private communication to the author. The earliest account appears to be that of Plateau (2) who records the finding of *Hydrachna cruenta* in springs of a temperature of 46°C., at Luxeuil, France, in the course of experiments on the determination of the thermal death point of several fresh water arthropods. This record is quoted by Brues (1) in recent papers on life in thermal waters. The identity of this species seems to be in some doubt, but it is probably a widely distributed European form.

Two other records have appeared during the past year. Uchida (4) has described a new species, *Eylais thermalis* from a single specimen found in a spring of temperature 42°C., near Taihoku, in the island of Formosa. Dr. Iwan Sokolow (3), examining material collected near Lake Baikal, Siberia, in springs of temperature 45°C., found three individuals which he has described very fully and named *Thermacarus thermobius*, a new genus and new species. He has also erected for them a new family, *Thermacaridæ*. The American material is a new species belonging to this genus, to which the name *Thermacarus nevadensis* has been given.

**Thermacarus nevadensis** sp. nov.

Pl. III, fig. 1-9.

The body is obovate, slightly widest in the region of the third pair of legs. Females measure 2.50-3.00 mm.; the males are slightly shorter and slimmer, the smallest, a young adult, being but 1.90 mm. It is thus seen to be smaller than *T. thermobius*. The color of the specimens, preserved in alcohol, was dull olive green with some traces of red. Two individuals showed white irregular branching streaks on the dorsal side. The body is low, somewhat arched; dorsally and ventrally the integument is heavily chitinized to form two shields, the dorsal somewhat the smaller, united by a thinner layer. Heavy ridges on the dorsal side enclose two irregularly oval areas, one inside of the other (fig. 1). The double eyes of either side are outside of these ridges. The median sense organ is just within the larger area and is inconspicuous. The heavy integument shows in alcoholic medium a transparent, somewhat irregular layer, below which are low elevations irregularly scattered about on a basal layer; the latter shows rounded pores in groups of some ten to twenty enclosed in an irregularly polygonal meshwork (fig. 7).

The conspicuous feature of the ventral side is the great development of the plates (figs. 2, 8, 9), the epimera closely resembling those of the related species. The first pair of plates, the largest, are fused not only ventrally but also dorsally so as to form a shallow cavity, reaching to the body margin or slightly projecting beyond it in the male, which encloses the small capitulum and the palpi. The fused epimera bear many hairs. The three remaining epimeral pairs are somewhat triangular, except that the fourth in the male is rectangular. Posterior to the epimera in the new species is another plate, a large median one, heavily chitinized and bearing the so-called anal spot, differing in size and shape in the two sexes and in contour in individuals of differing ages, and completing the closure of the genital areas.

The genital area in the male (fig. 2) is nearly circular, past the center of the body and enclosed by the fourth epimera and the medial posterior plate. Its valves are heavily chitinized

and support several long fine hairs. The female genital area is oval (fig. 8), situated a little above the center of the body and enclosed by the inner ends of the epimera as well as by the posterior plate. The valves of the opening are also heavily chitinized and bear hairs; they show more conspicuously than in the male a division into an anterior inner part and a posterior outer part, the latter showing numerous circular acetabula. One female (fig. 9), was found with the large ovipositor extended through the genital slit. This organ is a delicate, light colored structure within which could be seen the outlines of the nearly circular eggs.

The palpi (fig. 4, 5, 8) are very small and appeared always within the enclosure formed by the united first pair of epimera. They are flattened and are borne on the sides of a slender capitulum near the top. A conspicuous feature is the presence of two long curved doubly bifid bristles on the distal end of the second segment.

The legs are short, stout, increasing in length from first to fourth. The first three pairs are much like those of the related species and show the same partial union of the first two segments. They bear many heavy bristles, but these are somewhat longer than in the Asiatic form. All end in large double claws, orange red and beset with teeth on the curved side. The fourth leg in the female (fig. 6) is similar to the third but longer; in the male it is considerably modified (fig. 3) and doubtless used as a copulatory organ. The last three segments here are flattened, the fourth showing a plate-like expansion on the inner side; the last two segments are thickly beset with stiff hairs, the fifth being the longest and the sixth not much shorter, but broader with the claws lacking the teeth.

The types were secured in two collections from Nevada, a total of nine individuals.

Three males and four females were found in water of temperature of 43°C., fifteen miles north of Deeth; and a young male and a female in temperature 42.5°-45°C., in the Valley Hot Springs at Minden.

The new species is seen to be closely related to the Asiatic

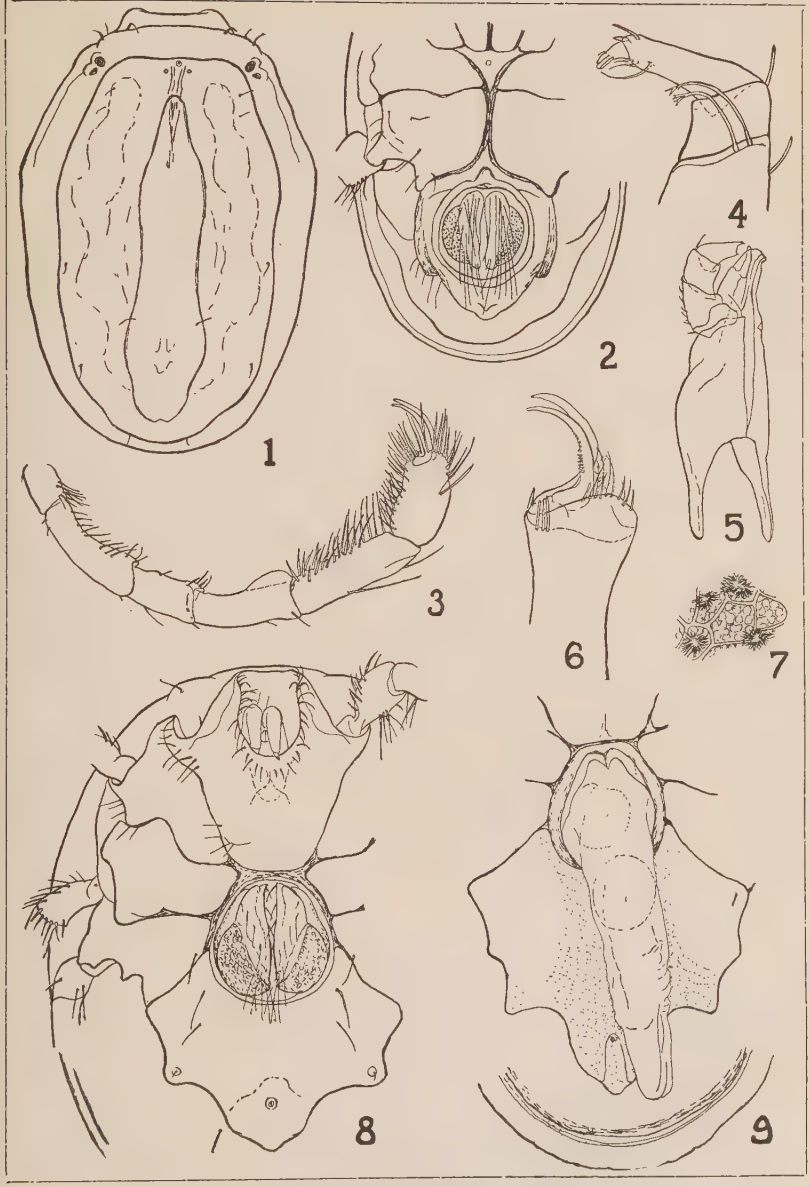
species but differs from it in several well marked characteristics. Specific characters of greatest importance in *T. nevadensis* appear to be the development of the heavy plate posterior to the epimera, the characters of the palpi with the large curved bifid bristles on the second segment; and the character of the fourth leg of the male with its last three segments elongated as well as flattened and richly supplied with stiff hairs.

## Literature Cited.

1. *Brues, C. T.* 1924. Observations on Animal Life in the Thermal Waters of Yellowstone Park, with Consideration of the Thermal Environment. Proc. American Acad. Arts and Sci., vol. 59, pt. 15:371-437.
2. *Plateau, F.* 1870. Recherches physico-chimiques sur les Articulés aquatiques. Pt. 1, Mém. Acad. Roy. Sci. Belgique, vol. 36, 68 pp.
3. *Sokolow, I.* 1927. *Thermacarus thermobius*, n. g., m. sp., eine Hydracarine aus heisser Quelle. Zool. Anz., LXXIII: 11-20.
4. *Uchida, Tohru.* 1927. Notes on a new Water Mite from a Hot Spring. An. Zool. Japonenses, Vol. 11, 2: 111-114.

## Explanation of Plate III

Fig. 1, dorsal view, male
Fig. 2, ventral plates, male
Fig. 3, fourth leg of male
Fig. 4, palpus, right, inner side (first segment lacking)
Fig. 5, capitulum and palpus
Fig. 6, end of fourth leg, female
Fig. 7, detail of integument
Fig. 8, ventral plates, female
Fig. 9, ovipositor extended




MARSHALL—THERMACARUS

# THE MALE GENITAL TUBE OF THE AMPHIZOIDÆ[1]

By J. W. Wilson

When Sharp and Muir (12) prepared their work on "The Anatomy of The Male Genital Tube in the Coleoptera" they were unable to procure specimens of the family Amphizoidæ. Since this family is one of the intermediate groups between the Carabidæ and the Hydrophilidæ, figures of the ædœagus will be

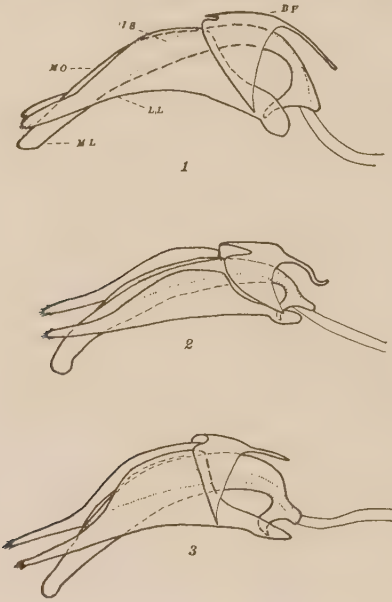



Fig. 1—Aedœagus of *Amphizoa insolens* Lec. from a lateral view; 2, ædœagus of *Amphizoa lecontei* Matth. same view; 3, ædœagus of *Amphizoa striata* Van Dyke.

of interest. The material was collected by Mr. P. J. Darlington during the summer of 1927. It includes the three species known from the Western United States, *Amphizoa insolens* Lec., *A. lecontei* Matth., and *A. striata* Van Dyke.

The ædœagus of Amphizoa is closely related to that of Pelobiidæ and Halipidæ. The median lobe (ML) is a simple

[1]Contribution from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 294.

cylindrical tube with a large median orifice(MO) extending the greater part of the length of the ventral side, internal sack (IS) simple and undifferentiated. The lateral lobes (LL) are large, produced, and coming together to form an articulation with the median lobe on the dorsal side. When retracted into the abdomen the ædœagus lies on its left side. The basal plate (BP) is small, attached to the lateral lobes by a short membrane, and rides over the lateral lobes. The structure of the ædœagi of the three species varies only in details of size and shape of the median lobe, the lateral lobes, and the basal plate.

The ædœagus of the Caraboidea Series is of two types, the less specialized being characterized by an undifferentiated internal sac. The Pelobiidæ, Halipidæ, Dytiscidæ, and Amphizoidæ possess such a simple sac. From a comparison of the figures by Sharp and Muir the Amphizoid ædœagus seems to be more closely related to the Pelobiidæ in the structure of the basal plate, and the size and shape of the lateral and median lobes.

The general shape of the Amphizoid ædœagus resembles that of *Dactylosternum subdepressum* Cast. which belongs to the Byrrhoid series of Sharp and Muir. In *Dactylosternum* the lateral lobes meet on the ventral surface, while in *Amphizoa* they meet and articulate with the median lobe on the dorsal surface. The basal piece in *Dactylosternum* is chitinized entirely, in *Amphizoa* the basal piece is not chitinized on the dorsal surface. This resemblance in shape then is only a superficial one.

# THE NESTING HABITS OF THE PULP-MAKING BEE, *ALCIDAMEA PRODUCTA CRESS*[1].

By Phil Rau,

Kirkwood, Missouri.

It really seems sometimes that the various types of twig-dwellers and mud-dwellers among bees and wasps vie with one another to see which can produce a new or novel type of architecture, for certainly they have utilized almost as many different forms and materials in accomplishing their one supremely important task, i.e. providing shelters for their broods, as man has done in precisely the same task. Man has, up to the present time, constructed his domiciles chiefly of caves or excavations, structures of mud, modifications of mud and clay, cement, stone, wood, thatch and, to some extent, paper. So far in our studies of the architecture of our smaller fellow-creatures, we have accounts of their using natural crevices or caverns, excavations, various structures of mud, wax, thatch (grass-carrier), wood (pith-borers and carpenters), and to a large extent paper, and we may add to that list modifications of clay. *A. producta*, in nesting in hollow stems, uses vegetable matter in a very unusual way; she chews green leaves into soft pulp, and while this is still wet she fashions it into plugs and partitions that make cells for the young.

Grænicher, who has made observations on this bee says, "From Davidson's descriptions of the nest, we learn that the Californian *Alcidamea producta* builds its nests in the stems of the elder tree by excavating the broken twigs and constructing of pith and clay the partitions between the cells, as also those near the opening of the nest (the 'outer defense,' as Davidson calls them). In our region this bee makes the partitions out of pieces of chewed leaves, and never uses clay for this purpose. In this variation of habits, *Alcidamea producta* remains true to the habits in vogue within the family to which it belongs, since

[1]Indentified by T. D. A. Cockerell.

some species of *Osmia* utilize clay, while others resort to vegetable matter. On July 20, 1903, I witnessed ** a female *Alcidamea producta* obtaining her leaf material from a wild strawberry *** the leaves of this plant are rather hairy on the under side, and when thoroughly chewed they form a felt-like, pliable mass."

My St. Louis specimens also failed to behave in just the same way as Davidson's in California; this species, unlike other twig-dwelling bees heretofore reported, makes plugs and partitions of a tough, tightly compressed, green substance which under the microscope proves to be vegetable fibres, *i. e.,* portions of leaves chewed to a fibrous pulp and moistened with saliva, which makes wonderfully strong plugs. This material is packed down in layers to form the plug, so that each mouthful forms a distinct stratum (see four layers at (a) in fig. 1). This is tough and well-nigh impenetrable when dry; hence the new adults emerging from beneath this roof cannot bite through, and have adopted an unusual and ingenious method of effecting their escape.

A general description of the nest, and the details of a few typical courses of action will impart a better idea of this bee's ways. These bees nidify in tunnels of elder, sumac or rose stems. Whether they excavate their own burrows or utilize some old ones left by other twig-dwellers, I cannot say. No evidence has been found of previous occupancy of the galleries; in one or two cases we noticed that the nest rested on the very bottom of the cavity, and in as many others the gallery seemed much longer than this bee had any need of, so the meagre evidence is equally divided on this point. The silky cocoons are transparent to a degree that gives one a fairly good view of the organism within.

There is much irregularity in the dimensions of the cells and the partitions. A typical series of measurements is as follows—length of cells in inches: 1, 5/16, 5/16, 1/8, 7/8, 3/8; thickness of partitions: 1/8, 1/8, 1/16, 1/4, 1/4, 1/8; air-space 1 1/2; outer plug: 5/8. In fig. 1 is shown a nest of this species, natural size, in the twig of elder; at "a" one sees the tight plug on the top of the nest, already referred to, and 4 cells are to be seen below "p", which are the partitions made of the fibrous vegetable material.

The two really unique features of the nests of this species are the material constituting these parts, as described above, and the young bees' way of getting past these plugs which when dried are almost as impenetrable as cement.

Like many other species, these bees arrive at the final stages of their development and emerge successively from the topmost

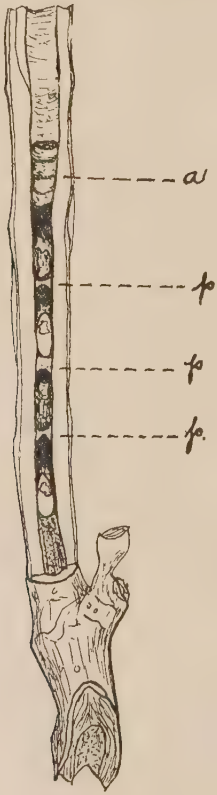



Fig. 1—Nest of *Alcidamea producta*. Natural size.

down, or in the reverse order of primogeniture. This sequence is apparent at the latter part of the pupal period from the pigmentation of the eyes. The organisms pupate with the head toward the exit.

A typical case in the details of behavior at the time of

emergence was that in a nest found in a sumac twig in December, 1918. The stalk contained a hollow six inches in depth, at the very bottom of which were four cells, close together. The top was hollow for three inches, except that the orifice was plugged for an inch with chewed-up vegetable material. The twig was kept indoors, and on March 13 two adults emerged. These were the two nearest to the top. Quite unintentionally I aided these two in escaping from their cells, by splitting open the stem for inspection; they emerged by merely biting their way through the side of their cocoons, and escaped. Fully developed young adults could be seen through the transparent walls of the other two cocoons. Mica was sealed over the missing wall to the very top of the stem to compel these remaining bees to attempt to get out by crawling upward by their natural route.

On March 26th I found that the third consecutive bee had emerged from its cocoon. Early next morning it was busy biting its way upward; it entirely demolished the empty cocoon of no. 2 in its upward course and kicked the fragments back in a heap at the bottom. It then had its head against the partitioning plug, where it faced a harder task at breaking through. The next morning, the beginning of the third day, this bee, while apparently in the same position, was industriously attacking this roof, the one which the elder sister, no. 2, should normally have cleared away for it. Its own cell was clean; all debris had been kicked to the bottom. It was attacking not only the roof or partition, but also the surrounding pith against which it was built; it had already bitten out enough of the pith on the sides to enlarge the original cell considerably. It must be remembered that no. 3 was doing additional work. Had nos. 1 and 2 emerged normally, each biting the roof out of its own cell, she would not have had this additional work to do, since each bee has only to break through the roof of its own cell to reach liberty. Unlike certain wasps, e. g. *Trypoxylon politum*, which can instinctively remove but one covering, and, even if they have the ability to go through a second wall, would rather die than make the attempt, this bee had already shown that she could suit her action to the needs, and not do so by mere instinct,

either, for already she had made attempts to get out by biting away the pith at the side.

As I watched her more closely at this part of her task I discovered that all of her biting and tugging was not for the one purpose of shredding the fibrous plug, but of moving it whole; even as I watched her she was, with jerk after jerk, working it slowly downward to a point where she had removed pith to loosen its pressure against the walls. I watched intently, doubtful of her success; but she knew her business better than I, and after an arduous session, a bite here and there and a jerk this way and that, she eventually succeeded in turning it up edgewise and pulling it downward as she crept past it, in a depression in the pith at the side; then she kicked it down among the other debris at the bottom. Thus my pretty theory, that she was digging in the pith at the sides to escape by going around the plug, like *Prosopis modestus*[2], was left in uncertainty, since now she had moved the whole plug bodily below, only cutting out enough extra space to permit the passing of her own body.

Thus the roof of her cell was disposed of. I should have made clear earlier that each partition comprises two parts or layers, each made of a separate mouthful of fibre; these discs, each about 1/8 inch thick, are near together but separate, one forming the roof of one cell and the other the floor of the cell above. Now that this bee had removed the roof of cell No. 2, she did not stop but went right on attempting to remove bodily the floor of No. 1 also, when a most interesting thing happened. She went to the left wall and bit out a small amount of pith adjacent to the disc, thereby enlarging the channel by perhaps 1/8 inch, again she attempted to remove the plug, but still it did not yield; so she went to the opposite wall and nibbled there a little also, and again tried to jerk the obstruction loose. Thus she continued for a half-hour, directing her blows upon the plug and her bites principally upon the left wall, and occasionally a few nibbles on the right wall; all the time the rasping noise made by her mandibles was distinctly audible. I was called away for a few minutes, and meanwhile the wonderful thing

[2]To be published later.

happened; when I again looked, she had bitten away so much pith at the left side, in her apparent attempt to loosen the unyielding plug, that she had opened a passageway around the side of it, through which she had escaped. This had led her directly into the bottom end of the empty cocoon above her and she accepted this as a passageway quite unhesitatingly. The channel had originally been only 1/8 inch in diameter, but she had dug out the pith at one side until at that point it was more than 1/4 inch. After this unusual exertion she relaxed for a few minutes of rest; she certainly looked very much at home as she lay there in the cocoon which fitted her perfectly—a replica of the one she had so recently left.

Eternal vigilance is the price of scientific data; had I not returned at that moment I should never have known her method. I expected that next she would go right on through the roof, but for twenty minutes she carefully cleaned out this cell, and with some difficulty pulled away the last bits of cocoon that adhered to the walls. There was no apparent need for this, except as a preliminary to attacking the wall to loosen the top plug. The old plug bottom that she had just passed still adhered to the walls and while her body now pushed it downward she made no further attempt to remove it; it was no longer in her way, so she went on directing her energy to the top plug and the pith on the left side near it. Her process of alternately biting and scratching out the pith, and belaboring the plug, was repeated, accompanied by the same rasping noises and occasionally the falling of bits loosened from the plug, showing that her efforts were not entirely for naught. Of course all this was making it easy for the fourth and last to emerge. Since No. 3 was doing the pioneer work that normally would fall to no. 1 and no. 2, and was succeeding manfully, it again brings to our attention the point that the first-born is not especially endowed with the ability to do worthy work, but it is all a matter of native intelligence, perseverance and strength. If this biting the way out is instinctive—chain instinct if you please—I wonder what happens to those which have no opportunity to use it,—those which merely follow the pioneers and have egress

with almost no labor. Is it possible that it is not dependent upon instinct, but in the emergency each brings to the fore all its intelligence and resources to cope with the situation, and that those which do not, die?

At the last observation at 7 p. m., I found no. 3 'way up in the top of the channel, having in my absence successfully passed the hard plug by biting her way around it through the soft pith. This compartment was an empty gallery of 3 3/4 inches, and she had evidently lost no time in traversing the long open stretch. She was already at the very top, attacking the final plug at the orifice. This was the "outer defence," 1/4 inch thick and tightly packed, and I was sorry, for I knew she would have a distressing time with it.

At this time, 7 p. m., no. 4 was barely out of its cocoon, at noon it had been just half-way out; this shows that its progress was slow. Its movements showed, however, that it was struggling hard to make headway through the 3/4 inch of debris that its predecessor had caused to fall down upon it. It reminded me of a cyclone victim trying to free himself from below a pile of broken rubbish. By 8 o'clock the next morning, this one had succeeded in escaping from the debris and was up at the top, complacently waiting beside no. 3, while the latter was at work cutting her way through the last obstruction. Doubtless no. 4 worked during the night, yet I could not quite overlook the way in which she sat by without disturbing herself in the least, waiting as a matter of course for the older sister to break the way for her. Whenever I noticed them during the forenoon the division of labor continued the same; no. 3 bravely struggled with the plug, often dropping tiny bits of it below, and digging out the pith bit by bit at the left side, while no. 4 quietly waited for her to finish her job.

When I returned at 11 p. m. and examined the nest, I found that no. 3 was out of the nest, and on the floor of the jar—dead. With her jaws she had torn to bits the formidable final plug and thereby acquired her liberty, but with it had come exhaustion and death. In this case futile attempts had been made to bite away the pith beside the plug, although at the point where

the plug was inserted it was sufficiently thick to make room for a passageway. No. 4 was also dead, in the same place where she was that morning. Whether exhaustion, delay or weakness caused her death I do not know.

One wonders if we may not have a case of the transitional or developmental state of a habit. Most bees in nests having real partitions, attack and perforate the partition itself; *Prosopis modestus*, we find escapes by cutting a new channel through the pith around the hard partition. The habit of this species of *Alcidamea* seems to be a reversion to a former habit, i. e., an attack upon the plug, modified by a new trick of removing bits of pith adjacent to the plug in order to loosen it, and this side cutting varying in amount from the removal of a few bits to the tearing out of enough of the pith in one place before the plug is dislodged to permit the passage of the insect's body, and in some cases the biting out of the pith at the sides without any evidence of attack upon the plug itself. One wonders whether *Prosopis* went through these stages of the arduous struggle with the hard discs before eventually adopting the easier method of detouring through the soft pith, and, if so, how long the species continued its struggle and suffering before is learned its lesson well.

Either the difficulty of the exit or the change of method or some such factor was costing the species a heavy toll of lives at emerging time. More than half of those I watched died before escaping from their secure imprisonment, or died of exhaustion immediately after gaining their liberty. Is this because of the difficulty of their situation, or must hardship or death always be the price of change?

Among the parasites which were found infesting the nests of these bees were *Stelis lateralis* Cress., [J. C. Crawford], *Epistenia osmiæ* [S. A. Rohwer] and *Stelis sexmaculata* Ash., [J. C. Crawford]. My twigs were gathered too late in the season to study the relation between parasites and host. A very important paper has been written by Dr. S. Grænicher[3] who was fortunate in finding nests with both parasite and host larvæ in the cells.

[3]Bull. Wisc. Nat. Hist. Soc. 3; 153-167, 1905.

# TWO NEW CLAVICORNS FROM THE UNITED STATES.

By Doris H. Blake,

Bureau of Entomology, U. S. Dept. of Agriculture.

There have already been published three papers dealing with the insect inhabitants of the small, round, cream-coloured fungus *Polyporus volvatus* Peck, which grows on dead and dying conifers. Hubbard[1] gave a list of eleven species of beetles found in the fungus on pine trees of the Pacific Coast Range from the Columbia River northward into British Columbia. Hopkins[2] mentioned that the beetle *Dendroctonus piceaperda* Hopkins was found associated with the same fungus in the spruces of the northeast. Weiss and West[3] in their recent paper on fungus insects and their hosts mention this fungus, although they overlook the fact that *Cryptoporus volvatus* Peck and *Polyporus volvatus* Peck are identical and treat the names as representing distinct species. Accordingly, when the writer collected this fungus last summer in the Coast Range near San Francisco and sent it to the National Museum, Mr. H. S. Barber was interested to find in the material sent a new and large species of *Cryptophagus*, a genus not yet recorded as breeding in it. The writer is grateful to him for preserving the beetles and their immature stages and pointing out to her the biological interest attached to the fungus host.

In connection with the description of this beetle, the writer is also describing a related species from Florida that has long been recognized as distinct but never published. Beetles were reared in numbers by Dr. E. A. Schwarz, H. G. Hubbard, and H. S. Barber from the flowers of *Zamia floridana* A. D. C.,and there is consequently in the National Museum a large series of the adults as well as the immature stages. The species was labelled in the collection as a new species of *Hapalips* and perhaps distributed to other collections under that name, but it appears to belong rather to *Pharaxonotha*.

[1]Can. Edt., vol. 24, 1892, p. 250.
[2]Bull. 28, n. s., U. S. D. A. Bur. Ent., 1901, p. 23.
[3]Proc. Biol. Soc. Wash., vol. 33, 1920, p. 33.

**Cryptophagus maximus,** new species.

Large (4 mm.), elongate, slightly convex, shining, reddish brown with short, moderately dense, but fine and recumbent, yellowish pubescence and coarse punctation. Head coarsely punctate both above and below, and especially pubescent over frons; eyes moderately small; no trace of median or transverse sutures on frons; a triangular projection below antennæ and in front of eyes, ending in a sharp point on either side of maxillary palpi, the latter well-developed. Antennæ about one-third

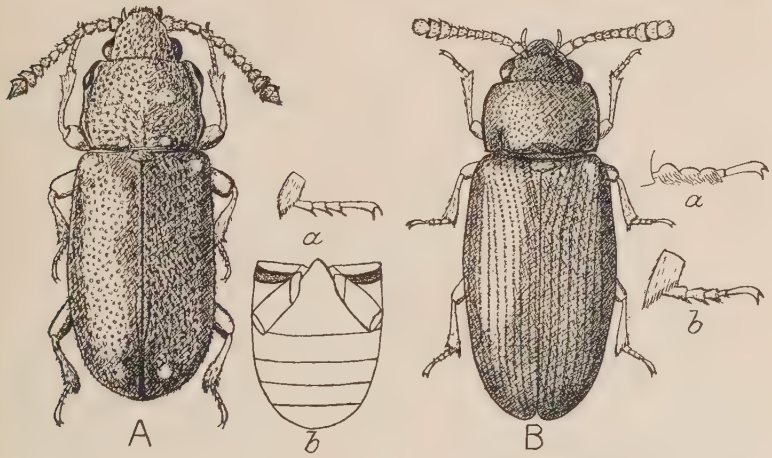



Fig. 1.—A. *Cryptophagus maximus*, (a) male hind tarsus, (b) ventral surface showing trochanters and abdominal segments. B. *Pharaxonotha zamiae*, (a) male (?) anterior tarsus, (b) hind tarsus.

length of beetle with loose 3-jointed club, the last two segments of club being approximately same width, slightly wider than first joint of club, and markedly wider than preceding segments; first antennal segment large, globose, second one-third smaller, third longer than any other except first. Prothorax somewhat wider than long with thickened lateral and basal margins; lateral margin at apical angle considerably thickened and reflexed forming an obliquely truncate apex, the sides narrowing and becoming subparallel behind, and again a little below middle projecting to form a subacute nodule, from this thickened nodule side nar-

rowing to base and with a sharp corner at basal angle; pronotum slightly convex with flattened disc, two slight callosities smoother and less punctate on either side and slightly in advance of middle of disc, and at base two other small knobby callosities, also polished and impunctate, these more closely set; a transverse basal groove extending from near margin and slightly deeper at outer ends thus forming a fovea on either side, the basal groove interrupted at middle. Surface of pronotum coarsely and densely punctate with flat shining interspaces, and somewhat pubescent. Scutellum broad and short, rounded at base, finely punctate and pubescent. Elytra convex, elongate, subparallel, wider than prothorax with small rounded humeri and depression within; punctation dense, coarse, shallow; surface shining and with light, short pubescence; sutural margin wide and distinct. Near apex of each elytron a small polished callosity, frequently paler in color, these callosities not as apparent in male but still quite discernible. Body beneath shining, covered with short, dense pubescence and densely punctate, the punctures on metasternum coarse and becoming confluent, on abdomen much finer and denser. First abdominal segment nearly equal in length to second and third together, the second, third and fourth gradually diminishing in length. Femora attached obliquely to trochanters, the latter small and elongate. Tarsi 5-jointed except the hind tarsi of male, these 4-jointed. Each segment of tarsus with long, sharply pointed tuft of hair beneath, the segments slender and not lobed.

Length: 3.6-4.2 mm. Width 1.3-1.5 mm.

*Type*: Cat. No. 40795, U. S. N. M. Three ♀ ♀ and one ♂ paratypes.

*Type locality*: Mt. Vision, alt. about 150 meters, Inverness (on Tomales Bay), Marin County California.

*Food plant*: In fungus (*Polyporus volvatus* Peck) growing on fallen pine tree, collected 7 August, 1927, by D. H. Blake.

The sexual differences are quite apparent. The males have 4-jointed hind tarsi, and show a slight concavity in the last three ventral segments, which in the females are full and rounded. One of the two males is markedly shorter and broader in proportion.

The fungus (*Polyporus volvatus* Peck) was collected 7 August and sent directly to Washington where five adults and two pupæ were taken from the material.

This species is much larger than any other species of *Cryptophagus* known in this country. Nearly all the North American species, except a few little known ones from Alaska, have been included in a table of species by Casey, and none measures more than 2.9 mm., only three-fourths as long as *C. maximus*. In addition, the species is not as conspicuously pubescent as usual in the genus, and has none of the longer, suberect hairs characteristic of many species of *Cryptophagus*. There is no species in the Casey collection that is closely related to this one. *C. boulderanus*, while large, is quite conspicuously pubescent, and *C. valens*, another large species, is quite unlike it in color and pubescence.

**Pharaxonotha zamiæ,** new species.

Elongate oblong-oval, shining, castaneous, very inconspicuously and sparsely pubescent, appearing glabrous except under a high magnification, pronotum with impressed line at lateral fifth extending from base about one-third length of pronotum. Head subtriangular with clypeus anteriorly truncate but as seen from above rounded; frons depressed with a depressed line extending obliquely to side margin in front of antennal socket; eyes large; head coarsely and very densely punctate. Antennæ about one-fourth length of beetle, club 3-jointed and twice as wide as preceding segments, the two segments preceding club slightly enlarged. Prothorax transverse, with narrow darker margins on all sides; lateral margin arcuate anteriorly and posteriorly but nearly straight medially; a deep, margined, longitudinal, somewhat curved sulcus on either side at lateral fifth extending forward nearly one-third length of pronotum and ending abruptly, these sulci connected at base by a transverse groove widening considerably in middle of base of pronotum. Punctation coarse and dense but not as dense as on head, pubescence very fine and inconspicuous. Scutellum small, rounded, indistinctly punctate. Elytra a little wider than prothorax with

sides subparallel, widest before middle and with well-rounded apex; narrowly margined, basal margin very distinct; humeri with a tiny notch at outer angle; striæ consisting of rows of coarse punctures, the first row converging from angle of scutellum to suture and joining suture at basal fifth, remaining striæ becoming less convergent and more parallel to suture; between these coarse rows of punctures on the interspaces another indistinct and sparsely placed series, all punctures bearing very inconspicuous short pale recumbent hairs only visible under high powered lens. Body beneath shining, punctate, more coarsely on metasternum, and with fine, short pubescence. First ventral segment about twice as long as second, second, third and fourth gradually decreasing in length, last wider and well rounded. Legs slender, rather short, tibiæ gradually dilated to apex, tarsi pentamerous, first three segments of tarsi very pubescent, the fourth segment being short, narrow and inconspicuous. Anterior tarsi of males (?) dilated and even more pubescent.

Length: 2.6-3.8 mm. Width 1-1.4 mm.

*Type*: Cat. No. 40796, U. S. N. M. 73 paratypes.

*Type locality*: Homestead, Florida.

*Other localities*: Larkins, Haw Creek, Crescent City, Biscayne, Naranja, Punta Gorda, Lake Worth, Miami, all in Florida.

*Food plant*: Reared from flowers of *Zamia floridana* A. DC. by E. A. Schwarz.

The type of the genus, *Pharaxonotha kirshi*, now known from Texas, Mexico, and Central America, was described by Reitter in 1875, having been found in drugs sent to Silesia from Mexico. The generic name suggests the character that differentiates this from allied genera,—the short, deep, impressed lines at the base of the prothorax. *Hapalips sculpticollis* Champ. also has impressed lines on the prothorax, and Grouvelle[4] in writing of *H. sculpticollis* states that he has not included this species in his table because he believes it ought to be put in another genus. *H. sculpticollis*, the only known specimen of which is before me, differs from the present species by having much longer impressions on the pronotum, very deep basally and connected by

[4]Memoirs Entomologiques 2, 1919, p. 91.

a deep, broad, transverse impression, and in the elytral sculpture, the interspaces being convex and appearing as ridges. The general shape of this beetle is also quite different. *Pharaxonotha kirshi* is a slightly larger, more elongate species, and is usually darker in colouring and more polished, being very shiny. In describing the genus *Pharaxonotha* in the volume of the Fauna of British India dealing with the Erotylidæ, Mr. Arrow states that the genus forms a link with the Cryptophagidæ, but that the stridulatory files and thoracic foveæ associate it with the Languriidæ. In both *P. kirshi* and *P. zamiæ* faint traces of these longitudinal lines behind the occipital line are to be found. Dr. A. G. Böving has shown me his unpublished drawings of the larvæ of *Languria* and the *Pharaxonotha* here described. The mouthparts of both are very similar and somewhat unlike the Cryptophagidæ. In some other respects *Pharaxonotha* is more like the Cryptophagidæ, and in the number of its ocelli it is like neither *Languria* nor the Cryptophagidæ.

# THE WORKING HOURS OF ANTS.

By Ernest Seeman,

Duke University.

During the summer of 1927 the writer observed the periods of activity of two species of ants in North Carolina, and was surprised to find that one species, at least, continues to work throughout the night and, to some extent, during rains. The detailed observations may be summarized as follows:

July 22-A caravan, *Crematogaster lineolata* (Say), was moving back and forth from a nest, located between the flooring and sub-flooring of a porch, to the topmost branches of a maple tree, where a colony of aphids were being milked for honey-dew. The distance traversed was about 40 feet. The workers leaving the nest carried sand and bits of dried mortar from crumbling masonry; those moving in the opposite direction evidently transported honey-dew. The sand and debris were being used to build a shelter over the aphids. The column was actively moving when first observed at 4 p. m., and at 11 p. m., two hours after dark, appeared undiminished in numbers and activity. The average speed of the workers was about two feet per minute, which enabled them to cover $5\frac{1}{2}$ feet or, one "ant-mile,"[1] 15 minutes being required to traverse the entire route of 40 feet. Thus an individual was traveling 360 ant-miles in a 12-hour period, if no time be deducted for loitering. As it is apparent from the observations below that ants may work not only 12 hours at a stretch, but for much longer periods, it will be seen that they possess great energy.

Between 11 p. m. and 3:30 a. m. of July 22 a thundershower occurred, abating by the latter hour. At that hour the ants' route was drenched with water, but the ants were found to be working in as large numbers and in as compact order as during the previous afternoon. About half their route ran underneath a floor, the remaining half extending across clay-covered ground

[1]An "ant-mile" is a convenient unit of measurement obtained by comparing the length of an ant's body with that of a man's in relation to a mile.

and up the maple tree. Slight showers were found to have no effect upon the ants' labor as they retreated to cover only during heavy, washing rains. When retreating, the food-bearers proceeded back to the nest and the majority of those that were outward-bound congregated at the end of the dry limit of the route. As soon as the rain abated they resumed activity. During their wait they did not rest, but moved about continually in the dry area.

July 23 (6 a. m.)—There appeared to be as many individuals in the line as ever, but the speed seemed a trifle slower, and a few individuals were loitering an inch or two outside the working-line. At 8 a. m. the line appeared to be going full speed; at 2 p. m., the same, except a half-dozen loitering in a fleck of sunshine (cool temperature had prevailed for some hours). The loiterers were never entirely still, however, frequently moving about in a small area. At 9 p. m. the line was as strong and rapid as ever, except where snails were crossing the route, which caused some ants to stop and feed on their slime.

July 24 (6. a. m.)—The line going full force; at 10 a. m. it was a little straggly. Weather sunshiny except that part of the course leading up the tree. At 5 p. m., the line unusually strong and more sand than usual being carried up.

No more observations were made at Durham until 21 days later. On August 14 (4:30 p. m.) the line was found to be as strong in numbers and movement as on the previous dates. At 8 p. m. the line was thicker than previously observed, and it was estimated to contain twice as many ants as it had contained at its lowest ebb. Instead of moving in single file, the line was five or six individuals deep in places. At 8:30 p. m. the marching ants appeared no less numerous. On August 15 (2 a. m.) there was still no diminution apparent. The weather at that hour was foggy, with diffused moonlight. On August 16 (6:30 a. m.) the line appeared to be moving at approximately half the strength of the night preceding. The weather was cloudy. On August 17 (daybreak) the line was moving in full strength.

No more observations were made this particular colony until some two weeks later. In the meanwhile, suspecting that

this all-night work was not an unusual occurrence among ants, I made casual inspections of a nest of *Crematogaster lineolata* at Black Mountain, N. C. These inspections, made around 9 o'clock in the evening, never revealed under my flashlight more than a half-dozen ants wandering about on the flagstones near the nest. Their comparative scarcity may be accounted for by the fact that the weather was cold at this station.

After August 14 I attempted to discover other night-working species at Durham. At 10 p. m. of that date I detected two or three individuals of the small black ant *Monomorium minutum* var. *minimum* Buckley gathering dry grass seed. I subsequently baited several spots with honey. During the day this soon attracted Monomorium as well as a dozen or more individuals of the large brown ant, *Formica pallide-fulva* Latreille.

I then made an examination in the early morning, before daybreak, and at the baited stations found only Monomoriums. A further search of the locality, however, revealed the little black ants milking aphids on the tender shoots of an apple tree. The heart-shaped *Crematogaster* species was also found harvesting grass seed, but though extensive search was made, none of the Formicas could be found, nor have I yet found any of this species working at night.

Observations at Durham were then suspended until September 2, when at 8 p. m. the working line of the Crematogasters was still found to be operating in full force. On September 3 (8. a. m.) the line was straggling, there were fewer individuals working and I observed for the first time what might be called sleep on the part of these ants. In a section of the line 7 feet long I observed that there were now only thirty ants, hardly a fourth of the number observed on other occasions. Six of these were apparently sleeping but were probably not totally unconscious, or if they were, were easily awakened. As the line of march at this point traversed the under side of a floor the ants were traveling with their backs toward the ground. The resting individuals were motionless, with legs and antennæ tucked in, but when approached by passing workers for the usual kissing salute the dormant ones immediately held out their antennæ and a passerby

would go on with no more than a slight touch, apparently respecting the siesta hour of its comrade.

On September 3 (10:30 a. m.) the traffic was even lighter, so that not more than twenty ants could be counted at work in the whole procession. This was by far the largest falling off in workers observed during the entire summer, either by day or night At this time seven sleepers were counted along the line, the remainder of the workers, whether asleep or awake, evidently being in the nest. On September 4, with warmer temperature, the line was again moving in full force. With lowering temperature the work gradually slowed down until on September 24, at sunrise, only one benumbed individual was out and at 7. a. m. (temperature 50) for the first time since the beginning of my observation in July, not a single individual was to be seen. On October 15, at noon, (temperature 59) six were out but moving slowly. This was the last appearance noted for the autumn.

In the spring of 1928 observations were made on the resumption of work by this colony. March 29, 6:00 p. m. (temperature 78) thirty-five individuals were seen to be following their old route. As the earth portion of the trail had been spaded under, it would appear that the ants followed the old route from memory and not as an odor-path. They followed exactly the same course up the tree but carried no building material, and by their movements appeared to be scouting. Until May 22, the last date of observation, the line continued to move steadily along the old trail except in very cold weather; and on the above date I observed that a few individuals were carrying sand up the tree, though apparently without any definite purpose, and as if they were merely acting upon a recollection of last season's activities.

It is realized that the foregoing observations are fragmentary and it is hoped that other observers will make a more extensive study of the subject. However, I shall venture to make a few surmises, rather than conclusions, from the limited data secured. The foregoing observations lead me to believe:

1. That excitement, caused by such circumstances as the discovery of aphids, or perhaps the building of a new nest, or

some other general disturbance, seems to occasion an outburst of prolonged activity among ants, at least in some species.

2. By the fact that the working line is considerably reinforced or diminished at certain times, it is possible that ants may work in relays, so that one portion of the colony may be resting in the nest while the other portion toils. Considering the fine point to which ants have developed their division of labor among various castes such a relay system could hardly be said to be beyond their powers. It may also be that ants require less rest than heavier animals, so that by a mere change in their rate of speed or by absorption of moisture or sunshine they receive renewed vitality.

3. The Crematogaster is probably a common night-worker, at least in North Carolina.

4. *Formica pallide-fulva* probably prefers to work in the sunshine rather than at night. The fact that this species is largely a flesh-eater may have some bearing on the matter, as its prey may be more available in daylight hours.

5. It is probable that temperature plays a large part in the working hours of ants. Just as an ant-colony suspends work above ground in winter, with the exception of infrequent journeys of occasional community foragers, it seems reasonable to suppose that any perceptible drop in temperature would lessen activity. Altitude, also, probably affects the work of ants. I attempted to make some observations in this regard at the summit of Mount Mitchell (6711 feet) during the summer, but was unable to find any ants at all, even during the day. It is probably too cold and high there, as none of the night-serenading insects ,such as katydids or crickets, were to be heard.

# SOME CUBAN CICADIDÆ, CERCOPIDÆ AND MEMBRACIDÆ

By J. G. Myers.[1]

The material on which the present notes are based was collected largely during parts of February, March and April, 1925, while the writer enjoyed the privilege of an Atkins Fellowship at the Soledad Laboratory. The chief species of importance to cane culture were dealt with in an earlier paper.[2] For some of the specimens I am indebted to Dr. George Salt, who took them after my departure. The Cicadidæ, Cercopidæ, and Membracidæ are now considered, while the Fulgoroidea, in which a number of life-history studies were made, are reserved for a later contribution. Owing to travelling, the study of my Cuban material has been interrupted for two years.

## CICADIDÆ.

### *Tibicen* (*Diceroprocta*) *biconica* (Wk.)

A single female of this species was taken by Dr. Salt at La Milpa, near Cienfuegos, 3rd July, 1925, and two recent last nymphal exuviæ at the same place a week previously. It has been recorded under the name of *Cicada bicosta* Wk. (which is a mainland form) as ovipositing in the leaf stalks of coconut palms (*U. S. Dept. Agric., Div. Entom.*, Bull. VI, pp. 20-23, 1902).

[1]Studies from the Biological Laboratory in Cuba (Atkins Foundation) of the Harvard Institute for Tropical Biology and Medicine.

[2]*Contr. Harvard Inst. Trop. Biol. Med.*, III, pp. 69-110, 1 fig. 1926. Other papers on these collections are in *Ann. Ent. Soc. America*, Sept. 1927, and, in collaboration with Dr. Salt, *Trans. Ent. Soc. London*, (1926), pp. 427-436, pl. xciii. The Homoptera in general of Cuba have been recently dealt with by Osborn, *Journ. Econ. Entom.* XIX, pp. 99-106, 1926; and *Ann. Ent. Soc. America*, XIX, pp. 335-366, pls. 30, 31, 1926; while the Cercopidæ (*Psyche*, XXXII, pp. 95-105, 1925) and the Membracidæ (Bull. *Brooklyn Ent. Soc.*, XX, pp. 203-214, pl. 1) have received comprehensive taxonomic treatment from Metcalf and Bruner.

*Odopœa walkeri* (Guér.)

A single female was captured by Dr. Salt at La Milpa, near Cienfuegos, 24th June, 1925, and two nymphal exuviæ collected on the same date.

The following species of cicadas have so far been recorded from Cuba. Doubtless many more remain to be discovered.—

*Tibicen* (*Diceroprocta*) *biconica* (Wk.), *List Hom. Brit. Mus.*, I, p. 120, 1850.

*Juanaria poeyi* (Guér.), *in* de la Sagra, *Hist. fis nat. Cuba*, p. 425, 1857.

*O. sagræ* (Guér.), *op. cit.*, p. 426.

*O. walkeri* (Guér.), *op. cit.*, p. 426.

*Proarna chariclo* (Wk.), *List Hom. Brit. Mus.*, I, p. 146, 1850.

*Juanaria mimica* Distant, *Ann. Mag. Nat. Hist.*, (9), VI, p. 455, 1920. An endemic genus.

*Uhleroides cubensis* Distant, *Ann. Mag. Nat. Hist.*, (8), IX, p. 644, 1912. Endemic genus.

## CERCOPIDÆ.

*Monecphora bicincta fraterna* (Uhl.).

2 specimens only, Soledad, 1st, 7th July, 1925, G. Salt. This was not seen by me during the dry season.

*Leocomia balloui* Metcalf and Bruner.

This froghopper was taken in some abundance by sweeping bushes in the Trinidad Mountains, at Mina Carlota. Usually the undergrowth was too mixed for one to ascertain a definite food-plant. In one case it was swept from *Asclepias curassavica* L.,[3] but this seemed exceptional. So far as present knowledge indicates *L. balloui* is definitely a hill species, not occurring below about 1200 feet.

**Leocomia collina** sp. n. (Figs. 1-2).

A tawny species, the tegmina obscurely mottled with paler, the crown long and acute. Sexes closely similar.

[3]For this and other plant determinations I am indebted to Mr. C. A. Weatherby, of the Gray Herbarium.

Head (Fig, 1, 1) considerably narrower than pronotum, the crown greatly produced, with the slightly upturned edge not quite in line with the eyes. Area between ocelli somewhat elevated. Ocelli nearer to each other than to eyes, about their own length

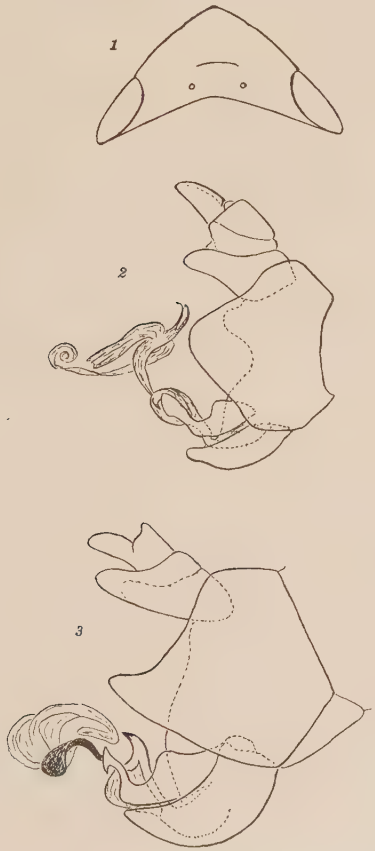



Fig. 1.—1, *Leocomia collina* sp. n.; 2, same; 3, *Dasyoptera variegata.*

from posterior margin of vertex. Frons flat, the cross-ridges visible only laterally. Pronotum just twice as wide as medianly long, widely subangulately excavated posteriorly. Scutellum 1.2 times median length of pronotum, apex long acute, with incurved sides. Tegmina 2.4 times as long as greatest width; veins very indistinct. Spines on hind tibiæ very stout.

Colour pale brown thickly covered on body and tegmina with short brown pubescence. Indications of a paler fascia about middle of tegmen and at about three-quarters. Hind wings infumated.

Length 4.3 mm. (holotype), 4.2 (allotype), measured to tip of closed tegmina.

The ædeagus is an extraordinary structure—very long and tubular, with the distal half more or less membranous, bent back on proximal half, to the Xth segment, to the under surface of which and to a conspicuous swelling of the membrane beneath, it is apparently fastened by hook-like projections. Part of this hooking apparatus is a long spirally coiled membranous arm. The proximal more chitinised part of the ædeagus is elbowed as it leaves the membrane of the pygophor, and more distally bears on each side a stout basally directed hook. In the figure (fig. 2) for the sake of clearness the lateral appendages of only one side are shown.

Described from 11 specimens, Mina Carlota, Trinidad Mts., Cuba, March, 1925 (Nos. 637. 641. 643. 647, 658, 664).

*Holotype, allotype*, Museum of Comparative Zoölogy, Harvard University.

*Paratypes*, Collections of British Museum and the writer.

This species differs from the genotype in having a large spine on the middle of the hind tibia, as do all the Cuban representatives (Metcalf and Bruner).

Judging from the descriptions, it differs from *L. grisea* M. & B. in its smaller size, the middle spine of hind tibia being much more than twice as long as basal one, the pronotum much longer than crown and differently shaped; from *L. balloui* M. & B. in its longer vertex and in colour; from *L. nagua* M. & B. in being larger and more slender in all proportions; from *L. mæstralis* M. & B. in having head much narrower than pronotum; from *L. pileæ* M. & B. in colouration and in the long vertex; and finally from *L. fulva* M. & B. in its smaller size, in the absence of straight sides to the vertex, and of carina to the pronotum.

*L. collina* was swept from mixed bushy undergrowth, and on two occasions from lantana (*Lantana camara* L.).

*Dasyoptera variegata* Metcalf and Bruner.

The male of this species, belonging to an interesting monotypic and endemic genus, was taken for the first time, and the external genitalia are herewith described and figured (fig. 3). It will be seen that their structure is a further specialisation and elaboration of that of *Leocomia*, as exemplified by *L. collina*. The ædeagus is extraordinarily complicated, with an apical semi-membranous portion which I have not been able completely to elucidate, in the one example available.

The male genitalia of the Cercopidæ afford most excellent taxonomic characters, especially in the ædeagus and the genital styles. The Xth segment is relatively simple in *Leocomia* and *Dasyoptera*, but in the common *Philænus lineatus* (L.)—an example from Massachusetts—this is produced into great caudo-ventral processes homologous with and resembling those of the Cicadidæ, but more flaring, whereas in cicadas they are usually parallel and sometimes fused, when they form the so-called "uncus" of American taxonomists.

The ovipositor of the female *Dasyoptera variegata* is extraordinarily small and weak—even more so than that of *Leocomia*.

The holotype of this species, and only other recorded specimen, was taken in eastern Cuba, at an elevation of 6770 feet on Pico Turquino. Curiously enough I did not find either of my two examples in the main range of the Trinidad Mountains, where *Leocomia balloui* and *L. collina* were both abundant. Both specimens were swept from miscellaneous underbushes, below the 1000 feet level, one at the Hanabanilla Falls (G. Salt) and the other in the wooded hills east of Soledad, on 7th April and 10th March, respectively.

*Lepyronia robusta* Metcalf and Bruner.

During the dry season this was the only abundant Cercopid—in fact the only adult—collected on the lowlands.

Sweeping wayside roughage and the coarse grasses, especially *Panicum maximum* Jacq., of the *potreros* nearly always, at least in February, yielded this species in great numbers. It oc-

curred sometimes on *Panicum barbinode* Trin., also, but not in the lush stands of this species which grew in damp places. *L. robusta* is essentially an inhabitant of the drier pastures, whence, however, it tended to disappear towards the end of February, save in places where the Guinea grass was more closely grazed and consequently (?) greener.

*Clastoptera* sp.

An undetermined species of this genus occurred in some numbers on the imported shrub, *Acalypha Wilkesiana* (Mull.) Arg., in the Soledad Botanical Garden during February. Efforts to rear it to maturity, either in sleeves or in the laboratory, were unsuccessful owing to wholesale destruction by a small parasitic wasp. When this has been determined, observations upon it and its host and an interesting Drosophiline inquiline larva will be published.

## MEMBRACIDÆ.

Only one species was collected during the dry season—or such part of it as was spent at Soledad. Two others were taken in the rainy season by Dr. Salt.

*Goniolomus tricorniger* Stål.

One example only, Soledad, G. Salt, 6th June.

*Monobelus flavidus* (Fairm.)

One specimen, Soledad, 9th June, G. Salt.

*Stictocephala rotundata* Stål.

The only abundant Membracid during my stay. It occurred plentifully during February in company with the still more common Cercopid, *Lepyronia robusta*, on the rough growth of *Panicum maximum* in the dry potreros. It was swept also from *Panicum barbinode* in considerably damper situations than those to which the froghopper was confined. Some examples were taken on mixed non-gramineous weeds, among which *Commelina nudiflora* L. bulked largely, on the edge of cane-fields and on *guardarayas*. It was beaten from adjacent undetermined bushes in the Botanical Garden and other Soledad localities, and

from young leafy shoots of the tree, *Guazuma tomentosa* Kth. So far as can be ascertained from collections of the adults only, it would thus appear that this is a highly polyphagous species.

I found it at Soledad only during February and March, but Dr. Salt took it there on 20th June, and at San Nicolas (Habana) on 15th April.

## BIOLOGICAL NOTES ON *NEMERITIS CANESCENS* (GRAV.) (ICHNEUMONIDÆ).

By P. W. Whiting,

University of Pittsburg.

On September 7, 1926 at Lowell, Massachusetts, in a grain and feed store heavily infested with *Ephestia kuehniella* Zeller and *Plodia interpunctella* Hb. there were observed a large number of females of *Nemeritis canescens* (Grav.) No males were to be found.

Six of these wasps were set with Ephestia larvæ and descendants were reared during the winter through six generations. Females only were produced totalling 3953. Since all of these except the 415 of the first generation were reared from bred virgins and since no males could be found among the numerous specimens in the store, the species appears to be almost or quite thelytokous.

Dissection showed that many eggs may be laid within the tissues of one caterpillar although only one maggot develops. The caterpillar is not paralyzed but feeds and grows normally and usually spins a cocoon. Ordinarily the full-grown maggot ruptures the skin of the caterpillar and spins its own brownish cocoon within the white silken tube of the latter. Not infrequently, however, the caterpillar is able to form a chrysalis in which case its chitinous covering left intact encloses the cocoon and pupa of the wasp. Adult wasps may be kept alive for several days if fed on honey and water.

There have been bred from single females from five to 43 offspring, but it is very likely that this number might be con-

siderably increased. Whenever a large number of caterpillars are supplied to one wasp, however, numerous moths appear so that many caterpillars escape being parasitized

No data were collected on the duration of the different stages of development, but under variable conditions of room-temperature records were taken of times of setting parents and of collecting progeny. Maximum periods for a complete generation thus ranged from 27 to 48 days inclusive with frequencies given in two-day intervals as follows: —44, 59, 126, 151, 143, 100, 88, 48, 20, 20, 15. These numbers show that the generation extends on the average slightly over a month, but may be somewhat shorter, while laggards may extend the time considerably.

## THE JURASSIC INSECTS OF TURKESTAN

By T. D. A. Cockerell,

University of Colorado.

In 1920 a very remarkable deposit of fossil insects of Jurassic age was discovered in the vicinity of Galkino, in Turkestan. The locality is within the territory of the so-called Cossack Republic, and is reached by the railway running east from Arys. Many of these insects have already been described by Martynov in Bull. Acad. Sci., Russia, ('25), but when I recently visited the Museum of the Academy at Leningrad, I was shown an amazing series of specimens, which when made known will profoundly influence many of our ideas concerning the age and evolution of various insect groups. The publications of Martynov on the Jurassic and Permian fossil insects will certainly be among the most important contributions to entomology in the next decade.

My wife and I had meant to visit the Galkino locality, but when we tried to make the necessary arrangements at Tashkent, so many difficulties presented themselves that it was impracticable to do anything. However, I was kindly permitted to study and describe some of the Galkino specimens in the Middle Asian Museum at Tashkent. Mr. Yankowsky, the director of

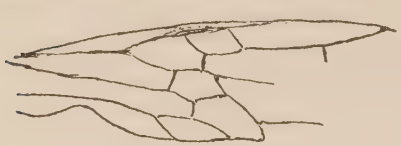
the Museum, is a keen entomologist, especially interested in Lepidoptera. The Galkino collections at Tashkent have mostly been collected, and partly studied, by Mrs. N. Y. Besobrasoff, of the Faculty of Physics and Mathematics, Central Asian State University. I am much indebted to her for courtesies in connection with my work. I made notes on seven of the most interesting fossils, but for the present describe only three. Some of the others, as for instance a cockroach with the head extended forward beyond the oval prothorax, not concealed as in modern forms, will probably be described from other specimens by Martynov. A very large Palæontinid, the anterior wings about 38 mm. long, hind wings about 18, is extraordinarily like a cicada, but shows a straight ovipositor, about 5.5 mm. long, projecting from the apex of the abdomen. A dipterous insect is of extremely modern aspect, with two large dark spots on the wings, much as in modern mycetophilidæ.

*Hymenoptera.*

Martynov described from Galkino a very interesting Tenthredinoid related to the Xyelidæ, which we have long regarded as a primitive group. It actually shows the lanceolate cell (really two cells, of course) contracted below and with an oblique cross vein as in modern forms. The antiquity of this structure is astonishing. In the Museum at Tashkent I found a second species of the same genus, which I propose to call *Anaxyela martynovi*. It is 13 mm. long (excluding ovipositor); black, parallel-sided, stout; width of thorax about 3.3 mm. of abdomen about 3.5 mm; head transverse, thorax oval, abdomen with the sutures rather boadly pallid; ovipositor straight, 4.5 mm. long, about 0.6 mm. broad, sharply pointed but not gradually tapering; wings ample, hyaline, with black veins (venation as shown in fig. 1), stigma small, lanceolate, defined by a slight infuscation above radius; anterior wing about 10.3 mm; radial cell 5 mm. black beyond this creamy white (exactly same on both sides, so evidently natural coloration); length of antennæ about 3.5 mm., or perhaps more. Martynov's *A. gracilis* has the head and body about 9.2 mm., but the ovipositor much longer in proportion, being half the length of head and body.

*Neuroptera*

An exceedingly large and broad anterior wing may stand as *Besobrasovia* (new genus) *latissima*. I showed my sketch to Dr. Martynov, and he had nothing like it. It is of triangular shape, with rounded apex, 72 mm. long, width across middle about 48 mm., outer margin gently curved, about 58 mm.; costa straight, broad costal field (about 6 mm. broad near base) crossed by slender oblique veins about 1.5 mm. apart, but breaking up along the costa into very numerous fine veins; Sc and R running parallel about 2 mm. apart, and Rs about 2 mm. below R and also parallel with the others, the Rs emitting below eight very



1

Fig. 1.—*Anaxyela martynovi* sp. nov., wing.
Fig. 2.—*Besobrasovia latissima* gen et sp. nov., wing.

oblique branches before the subapical region, these branches about 6.5 mm. apart at points of origin, but from one to the other, as they run subparallel, is only about 3 mm. In the submarginal region, about 13 mm. from margin, these branches regularly fork, and apically there are very many fine parallel veins. The media has at least three branches below. The cubitus, arising at base of media, forks at about 9 mm. from base of wing, and is further subdivided beyond. The anals are obscure. The specimen bears the numbers 162, 2903. The venation agrees closely with that of *Kalligramma hœckeli* Walther, from Solnhofen, but the apex is much less rounded, and the fine close cross-veins are lacking. There is apparently closer affinity with such species as *Brongniastiella inconditissima* Handl., also from Solnhofen, but it differs from that genus by the fewer oblique nervures below radius, and also in shape. In the Turkestan deposits at Kapadac-may, a genuine *Kalligramma* was found, and this has been described by Mrs. Besobrasoff. It is of great size, the anterior wing about or nearly 50 mm. broad in middle,

and showing well the fine close cross-veins so characteristic of the genus. The hind wing also shows the large ocelliform mark. The ocelli of the hind wings are curiously similar to those of the orthopterous genus *Tanusia* and *Pterochroza*, from Brazil.

*Orthoptera*

The interesting genus *Absitus* of Martynov consists of long-horned grasshoppers of considerable size, with transversely banded wings. The males are said to have a well-developed musical apparatus. The genus was founded on *A. fasciatus* Martynov but to my astonishment when I called on him, Martynov produced drawings of a whole series of species, all showing the same general type of marking, though with much diversity in details.

However, still another species, not represented in his series, is preserved in the museum at Tashkent. I will call it *Aboilus besobrasovæ*. Figure 2 shows the pattern of the broad tegmen, so far as preserved, and a detail of the venation, with the characteristic oblique cross-veins, in the region of the black cuneiform mark shown just above. The insect is about 52 mm. long, with heavily spotted or banded tegmen which probably had a length of about 70 mm., but the apical part is not visible. The outline is not well shown, and the figure does not pretend to any exactness on this point. The ovipositor, not previously known in the genus, is well preserved, directed obliquely downward, about 18 mm. long and 2.5 mm. wide in middle (lateral view), straight ensiform. Hind tibiæ about 27 mm. long and 1.5 wide in middle, posteriorly with only small spines. Wings (tegmine) pallid, with heavy black markings directed transversely, the largest being long-triangular or wedge-shaped, about 8 mm. long. Width of tegmen at fourth transverse band 22.5 mm., at third band 19.5 mm., at second band 17, and at first band 14 mm. The first dark band is about 12 mm. from base the second about 9 mm. beyond it, the third about 5 mm. beyond that, the fourth about 5.5 mm. further, then the fifth and sixth after shorter intervals. These bands consist of series of broad spots or markings, either separated from one another, or united

by slender isthmi. In an area about 27 mm. long and 8 mm. broad, where the abdomen of the insect was, the marking is absent, though it must have been originally present. The third and fourth bands are especially characteristic, having wedge-shaped marks with their bases on anal margin of wing, and above them, but separated from them, ovate spots, more or less pointed at the ends. The two outer bands consist of a series of large suboval spots united by slender or short bands.

I am much indebted to Mr. Uvarov at the British Museum for calling my attention to similar characters in modern species. Thus the oblique cross-veins are beautifully shown in the genera *Pseudophyllus* and *Cratylus*, which however lack the color markings. The cross-banding and spotting is well seen in other living genera, as in the Cystophyllid *Sanaa imperialis* White from India, which is beautifully shown in colors on one of the post-cards issued by the Museum. Much more like *Aboilus besobrasovæ* in markings is *Typhoptera donovani* Donovan, also from India.

Although it has nothing to do with the fossils, I venture to add a note on the extraordinary features of the South American *Catasparata histrio* Brunner, *Mimetica picteti* Kirby and *Typhophyllum mutilatun* Walker which were shown to me by Uvarov. The tegmina are exactly like dry leaves, in some cases appearing as if spotted by fungi, but the extraordinary thing is that the males (only the males, as Uvarov noted) have on the costal margin a semicircular incision exactly as if cut by a *Megachile* bee. *Megachile* is of course richly represented in the same country. The simulation is perfect, but its biological significance is not so clear.

# NOTES ON THE LIFE HISTORY OF *PELECIUM SULCATUM* GUÉRIN[1].

By George Salt.

On the ninth of December, 1926, while searching for insects at the edge of a banana plantation near Sevilla, Department of Magdalena, Colombia, I came across a beetle pupa lying about 5 cm. deep in the soil of a grassy area a few metres distant from the bananas. The pupa was casually examined and then isolated in a vial. Early on the morning of December eleventh it was found to be accompanied by a small, spindle-shaped larva which appeared to be eating it. Twice the larva was moved a few millimetres off, and each time it made its way back and lay with its mouthparts touching the pupa. By noon the larva had grown enormously and had turned slightly darker in colour. On the morning of December twelfth it had completed its meal and was about 8 mm. long and 2.5 mm. in maximum diameter, tapering to each end. Nothing remained of the beetle pupa but its shrivelled skin; it had been completely consumed in twenty-four hours or a very little more. On December fifteenth the larva seemed about to pupate but failed to do so, and three days afterwards was dead and mouldy.

Some months later, in the same general locality, a similar larva was found eating a soft young leptodesmid millipede in its transformation chamber in the damp soil of a banana field. It completed its meal, lay for some days quiescent, and then pupated. After a pupal period of five days it emerged as an adult beetle which Mr. Howard Notman has kindly identified for me as *Pelecium sulcatum Guérin*, one of the Peleciinæ (Dupuis, 1913), an aberrant group of Carabidæ. As nothing seems to be known of the immature stages and life history of any member of the subfamily, and as, in the course of my work, several other larvæ, pupæ, and adults of this interesting beetle were obtained, I venture to offer these very sketchy notes.

[1]Contribution from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 293.

In all, six larvæ were found, four devouring soft millipedes, one eating a beetle pupa, and one, taken by my assistant, was reported to me as feeding on a chrysomelid larva but the host was not brought in for identification. It was attempted to raise all the larvæ and no specimen was preserved, so that only a field description of the stage can be given. The full-grown larva is dirty white in color, with a gray, median, dorsal line extending from the thoracic segments to the posterior tip of the body. The length varies, probably with the size of the host, from 7 to 10 mm., the form is always stout and spindle-shaped, the head-capsule elongate. The three pairs of thoracic legs are so short in comparison with the unwieldy bulk of the body that at this stage, at least, the larva is incapable of active or extended movement. As eggs were not obtained, the full duration of the larval stage is unknown. The period of active feeding, however, is very short. The specimen first mentioned completed its meal of a beetle pupa and became 8 cm. long in a little over twenty-four hours. Another which fed upon a soft millipede grew in length from 4 mm. to 9 mm. and increased several times in bulk in about forty-eight hours. Only one of the six larvæ was successfully brought to maturity.

When first formed the pupa is entirely whitish, but it assumes darker colours as it matures. Twenty-four hours after pupation the eyes are faintly gray, in another day they have become brown, and after seventy-two hours are entirely black. At the end of the fourth day the eyes are black, the mandibles brown, and the posterior tarsi darkened. The duration of the pupal stage in the only specimen that was raised from larva to adult was five days. Two pupæ found in the field, whose age at collection I estimated from the colour to be one or two days, emerged four days later. The pupal period, therefore, is in the the order of five or six days. Eight pupæ in all were found in the field; naked, in small cavities four to eight centimetres deep in the soil. Only two of these emerged as adults; injury at the time of excavation accounting for the high mortality.

When it first emerges the adult beetle is still cream-coloured, but rapidly darkens and in a day is quite black though the chitin

at that time is not yet completely hardened. One adult specimen, entirely black though still somewhat soft, was found in an oval cavity in the soil together with fragments of a millipede which had probably served as its host. Nothing was observed of the habits of the adult beetle; it is able to move fairly quickly but does not impress one as a particularly active insect. Adult specimens vary greatly in size, probably with the size of the host.

In this brief outline notice has been taken of the late larval stage, the pupa, and the adult; the egg and the early larval periods remain unknown. This lacuna in our knowledge is unfortunate. Indeed, one of the most interesting questions in the life history remains unsolved; the problem, namely, of how the Pelecium larva comes to its host. There are two possibilities; either the female beetle lays her egg upon the intended victim, or the very young larva itself seeks out its prey.

In 1905, Silvestri described the life history of a lebiine carabid, *Lebia scapularis* Fourcroy, which feeds in the larval stage on the pupa of the elm leaf beetle, *Galerucella luteola* Müller. He found that the young larva of the Lebia is of an elongate form, with well-developed mandibles and legs, and able to move about with agility. In this stage it seeks and attacks a pupa of Galerucella. Eating voraciously, it soon becomes fusiform in shape, increases considerably in size, and, although retaining its anatomical characters, loses its ease of movement, its legs, now comparatively short, scarcely serving to move it slowly even when aided by vermicular movements of the abdomen. Later, it constructs a cocoon and therein transforms to a second stage larva, a pupa, and finally to the adult.

Silvestri's account of Lebia suggests that Pelecium likewise has a small, active, primary larva which itself seeks out its prey, and then, on account of its great increase in size, loses its power of rapid movement and becomes the fat, fulsiform, inactive larva I have described. As far as my observations go, however, Pelecium has not a distinct secondary larval stage such as Silvestri describes for Lebia, and it certainly does not construct a cocoon in which to pass the pupal period.

A competent coleopterist, my friend Mr. P. J. Darlington, now in Colombia, writes that he has obtained larvæ and adults of *Pelecium sulcatum*; and it is to be hoped that the curious life history indicated by my own fragmentary observations will soon be completely eludicated.

*References.*

Dupuis, Paul.

1913 Peleciinæ. Genera Insectorum (Wytsman), Fasc. 146, 5 pp., 1 pl.

Silvestri, Filippo

1905 Contribuzione alla conoscenza della metamorfosi e dei costumi della *Lebia scapularis* Fourc. Redia 2 (1): 68-84, pl. 3-7.

## SOME COLOMBIAN PHORIDÆ FROM THE NESTS OF STINGLESS BEES.[1]

By Charles T. Brues.

Dr. George Salt recently gave me a series of several species of Phoridæ which he collected in the neighborhood of Santa Marta, Colombia during the course of some studies on the biology of certain stingless bees.

One of the species is undescribed, and as Dr. Salt wishes to refer to it in the account of his investigations, I take this opportunity to describe it.

### **Melittophora**, gen. nov.

A member of the Platyphorinæ as defined by Schmitz. Body very broad and much flattened, with stout legs and fully developed wings in the female.

Head (Fig. 1, A) in front view slightly more than half wider than high, strongly flattened and closely applied to the thorax; the occipital margin acute and the posterior surface

[1]Contribution from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 295.

concave; eyes small, distinctly pubescent. Front clothed with fine short hairs, longer along the lower margin; bristles small, twelve in number, distributed as follows; one at lower lateral angle, one just next the edge of the antennal cavity, one next the eye margin at middle of front, one near upper angle of the eye and four near upper margin in line with the lateral ocelli. Antennæ widely separated, oval in outline, with a nearly apical, bare arista. Proboscis well developed, nearly as long as the head-height; palpi small, but little longer than thick, with five moderately long bristles near the tip. Ridge between eye and

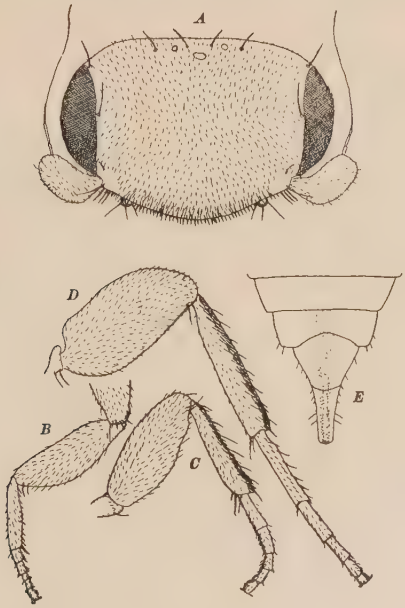



Fig. 1.—*Melittophora salti* sp. nov., female. A, front view of head; B, C, D. fore, middle and hind leg; E, apex of abdomen.

mouth opening with about eight very long and stout downwardly directed bristles, the two next the proboscis on each side closer together and weaker than the others; only the four on each side nearest the antennæ are long enough to be visible in front view. Ocelli well developed, the median one larger. Thorax broad, the mesonotum nearly one half wider than long with

about four bristles along each lateral margin. Scutellum very short and broad, fully four times as wide as long, with ten bristles along the posterior margin, placed as a series of four toward each side, with a widely separated pair at the middle. Abdomen very broad at the base, triangularly narrowed apically, and but little longer than wide at base; not hairy or bristly; second segment about four times as long as broad, twice as long as the third; third to fifth of about equal length; fifth with the apical margin concave; sixth subtriangular, as long as wide at base and as long as the second. The upper surface of the abdomen is nearly flat, except at apex, as the sixth segment bends down strongly. Ovipositor heavily chitinized, directed downwards and backwards, one-half as long as the abdomen. Legs very stout and short; the hind femora much flattened, more than one-third as broad as long; tibiæ with setulæ, but without any spines. Wings fully developed, very thin and transparent; costal vein reaching to the middle, with very short, closely placed bristles; first vein straight, meeting the costa near the tip; third vein not forked, but slightly thicker apically; last section of costa one-fourth as long as the preceding. Fourth to seventh veins very pale and delicate, scarcely discernible, the fourth curved at base, straight apically; fifth and sixth slightly sinuous, seventh curved.

Type species *M. salti* sp. nov.

This genus is related to Euryphora and Microplatyphora but differs from both in the chitinized ovipositor and the presence of fully developed wings in the female. It resembles the former more closely in the form of the greatly thickened legs, but the hind tibiæ are without large bristles.

### Milittophota salti sp. nov.

♀ Length 1.4-1.6. Black, including the halteres. Legs very dark brown or piceous. Wings hyaline, very highly transparent, the heavy veins black. Front and mesonotum subshining, clothed with very fine, microscopic, appressed hairs. Abdomen similar, but less noticeably shining, except at apex. Setulæ of hind tibiæ delicate, about nine in number, about half as

long as the width of the tibia; in addition the anterior surface of the tibia is clothed with very minute short bristles, grouped more or less distinctly into transverse rows.

Type and paratypes from Rio Frio, Magdalena, Colombia, October and November 1927 (George Salt); in nests of *Trigona amalthea* Olivier.

### **Pseudohypocera** Malloch

Proc. U. S. Nat. Mus., vol. 43, p. 439. figs. (1912).

### **Pseudohypocera nigrofascipes** Borgmeier

Zeits. Deutscher Ver. Wissensch. u. Kunst, São Paulo., Jahrg. 3, p. 132 (1922)

Borgmeier, Arch. Mus., Nac. Rio Janeiro, vol. 25, p. 183 (1925)

There are a number of specimens of both sexes. The apical abdominal segment of the female is usually retracted, but when exserted it is seen that although the sixth and seventh segments are soft and membranous, the eighth is heavily chitinied to form an ovipositor. This is about twice as long as wide, slightly narrowed apically. Below the surface is faintly longitudinally aciculate, and above with a triangular smooth space basally and convergent aciculations apically. It is considerably flattened in cross section.

Rio Frio, Magd., Colombia; Sevilla, Magd., Colombia; August (George Salt), in nests of *Trigona amalthea* Olivier and *Melipona interrupta* Latr.

### **Aphiochaeta scalaris** Loew.

This common and widespread species in the American tropics, is represented by numerous specimens. Rio Frio, Magd., Colombia, June-July (George Salt).

**PIN-LABELS IN MULTIPLES OF 1000, ALIKE**

**ONE DOLLAR PER THOUSAND**

**Smallest Type. Pure White Ledger Paper. Not over 4 Lines nor 30 Characters (13 to a line) Additional Characters, 3 cents each, in total and per line, per 1000. Trimmed so one cut makes a label.**

C. V. BLACKBURN, 7 Emerson St., STONEHAM 80, MASS.

---

## CAMBRIDGE ENTOMOLOGICAL CLUB

A regular meeting of the Club is held on the second Tuesday of each month (July, August and September excepted) at 7.45 p. m. at the Bussey Institution, Forest Hills, Boston. The Bussey Institution is one block from the Forest Hills station of both the elevated street cars and the N. Y., N. H. & H. R. R. Entomologists visiting Boston are cordially invited to attend

---

**We are the Headquarters for Entomological Supplies and Specimens.**

**Special attention is called to our hand made Schmitt boxes.**

**American Ent. Co. Steel Pins, Klaeger Pins, Life Histories of Beneficial and Injurious Insects, Type, Mimicry and Protective Coloration Collections; also Collections of Household, Garden, Orchard, Forest and Shade Tree Pests. Living Pupae from November to March. Exotic Insects of different orders; also Biological material for dissection.**

**Catalogue No. 33, Entomological Supplies, free on application.**

WARD'S NATURAL SCIENCE ESTABLISHMENT

**84-102 College Ave., Rochester, N. Y.**

# BACK VOLUMES OF PSYCHE

**The Cambridge Entomological Club is able to offer for sale the following volumes of Psyche. Those not mentioned are entirely out of print.**

Volumes 2, 3, 4, 5, 6, 7, 8, 9, 10; each covering a period of three years, $5.00 each.

Volumes 12, 14, 17, each covering a single year, $1.00 each.

Volumes 18, 19, 20, 21, 22, 23, 24, 25, 26, each covering a single year, $1.50 each.

Volumes 27, 28, 29, 30, 31, 32, 33, 34, each covering a single year, $2.00.

Orders for 2 or more volumes are subject to a discount of 10%.

Orders for 10 or more volumes subject to a discount of 20%.

A set of all the volumes available (29 in all) will be sold for $58.00.

All orders should be addressed to

F. M. CARPENTER,

Associate Editor of Psyche,
Bussey Institution
Forest Hills, Boston, 30, Mass.